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MARCH/APRIL 2007 • VOL. XXVIII, NO. 6

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Cover photo: Pneumatic sprayer at Robert Sinskey Vineyards (Napa, CA). Photo by Fred Lyon

"To stimulate continuing improvement in the wine industry."

Mendocino

We've been too busy Now it's time to tell

What do you know about Mendocino County? Probably not a great deal, as our focus has been on growing fine winegrapes for world-class wines rather than telling our compelling story. We are finding that there's a whole generation of new winemakers who know very little about Mendocino winegrapes. Despite our well regarded but rather limited recognition, premium winegrapes have been grown in Mendocino County for nearly 150 years or 5 generations, so it is a deep part of our heritage here.

"Behind every great wine is a great farmer, and we've got more than our share."
You may have noticed wine critic praise for our world-class Pinot Noir, generally out of Anderson Valley. Perhaps, you've tasted some of the terrific wines that continue to be made from grapes sourced in vineyards planted by some of our settlers in the late 1800's– names like Ciapusci, Zeni, and Dupratt. Or possibly you've seen the 90+ scores for selected Mendocino vineyard-designated wines produced by our own fine wineries as well as some of our southern neighbors like Williams Selyem, Rosenblum and Copain, to name just a few.

Yet that is just the story's beginning...
So, we've decided that it's time to tell many more of the "secrets" about the things that make Mendocino winegrapes the highest quality while also good value for money. Here, as told by five of our seasoned vineyard sages, is what every winemaker should know about what is happening right now in Mendocino County.

Consider this Chapter 1
Please watch this space in the future as we provide more of our unique story, including how we've added modern science and technology to the solid traditions of growing vines the old ways.

Discover Mendocino Wines at any of these festivals

Apr 5 to 8 - Redwood Coast Whale & Jazz Festival, Point Arena & Gualala

May 5+6 - Hopland Passport, Hopland

May 19+20 - Pinot Noir Festival, Anderson Valley

Jun 22 to 24 - The 9th Annual Mendocino Wine Affair, Mendocino

Jun 16+17 - A Taste of Redwood Valley, Redwood Valley

Jul 10 to 21 - The 2007 Mendocino Music Festival, Mendocino

Aug 25 - The 5th Annual Yorkville Highlands Wine Festival, Yorkville

Aug 25+26 - Pure Mendocino, Ukiah

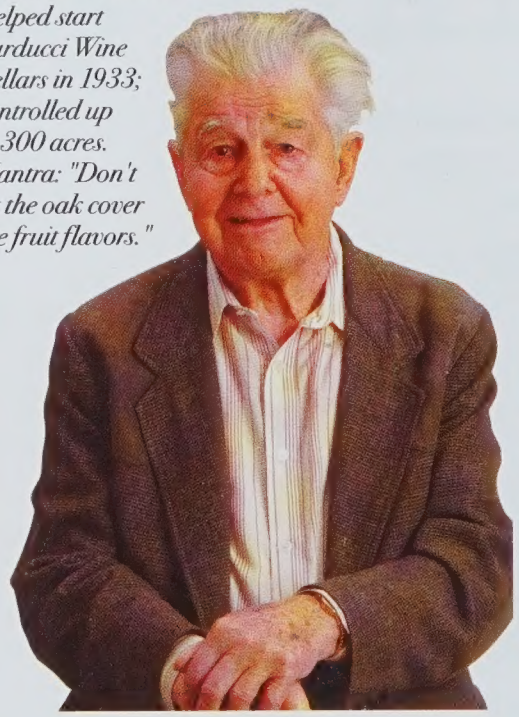
Sep 8 - WineSong!, Ft. Bragg

Oct 27+28 - Hopland Passport, Hopland

For more info: (707) 468-9886
www.MendoWine.com

Announcing: The Mendocino Winegrape and Wine Commission

by John Parducci
Helped start Parducci Wine Cellars in 1933; controlled up to 300 acres. Mantra: "Don't let the oak cover the fruit flavors."



I'm very supportive of the The Mendocino Winegrape and Wine Commission. It is a new cooperative group formed last summer and could be the best thing that has ever happened here. My grandson, Rich, is one of the eleven current Commissioners.

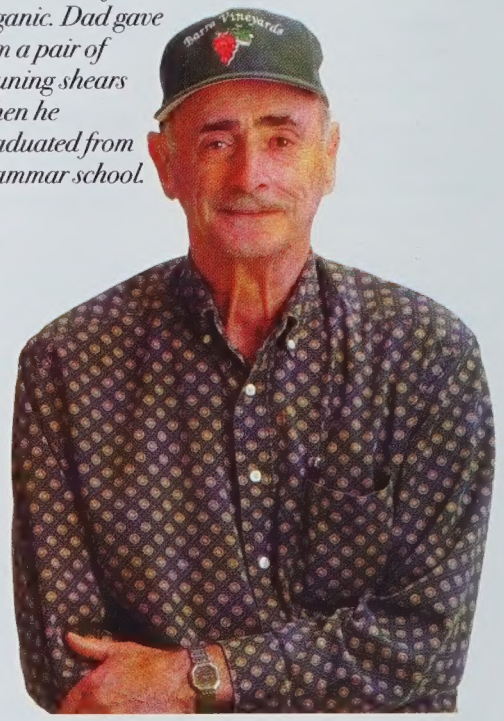
Our new logo

We're one-of-kind in that we're the **first in in our state that combines both growers and vintners** in a California agricultural commission organized to promote the general interests of the Mendocino County wine community.

Our largest promotional budget ever
We have aggressive plans and a promotional budget of nearly $4 million over the next several years. And we intend to use every penny to effectively tell our amazing Mendocino story! This is just one of five unique initiatives highlighted in this ad that are working in our favor and that we believe will aid the increasing success of Mendocino County. You may be surprised to learn of some of these undertakings, yet each will contribute to changing Mendocino from undiscovered to a highly recognized, world-class wine region. For more information regarding any of these topics, please call our Commission office on (707) 468-9886.

Masters of Organic Grape Growing and the National Leader

by Pete Barra
Barra Family Vineyard. 43 acres certified organic. Dad gave him a pair of pruning shears when he graduated from grammar school.



I'm a certified organic farmer, and I believe growing that way allows the "terroir" to come through. Keep in mind that all grapes for 1,000's of years were grown organically. What many do not realize is that **Mendocino leads the nation** in certified organic winegrowing. We have **2,820** acres or 18% of total acreage certified organic and another 7% or so that aren't yet certified, which means a combined total of about 25% of our acreage is being farmed organically.

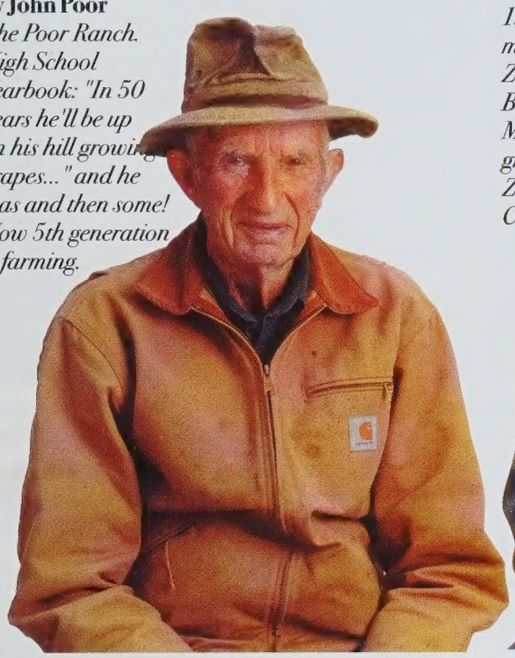
Mendocino leads the nation in organic vineyard acreage with 2,820 acres certified. In California less than 2% of winegrapes are certified organic; in Mendocino it is 18%.

We're very proud of the fact that over 50 vineyards here are growing organically and many have been for 10 to 20 years. With the extra effort involved in organic farming, our growers would argue that this is just one of many factors supporting the consistent high quality of our fruit. Some people went back to the land; yet many of our farmers never left it.

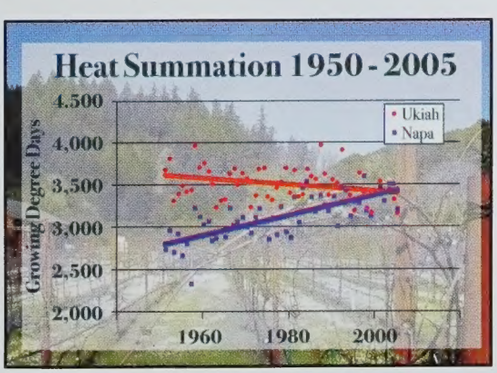
doing what we love - growing fine winegrapes. folks our unique and special story.

Does Climate Change mean we're more like Napa County?

by John Poor
The Poor Ranch. High School Yearbook: "In 50 years he'll be up on his hill growing grapes..." and he was and then some! Now 5th generation is farming.



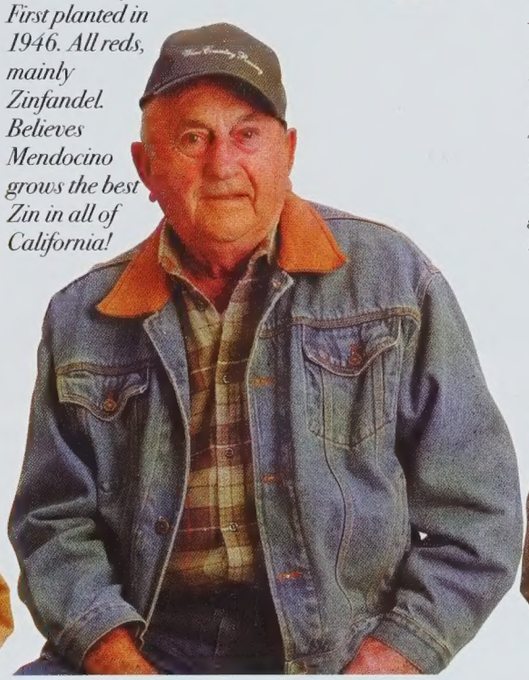
Having lived here all my life on a ranch that has grown fine winegrapes since 1888, I've noticed a very slight climate cooling over the years. The changing weather patterns may bode well for the future of winegrape growers in Mendocino County. An analysis of temperature data since 1950 shows that the climate in Mendocino's Ukiah Valley has gradually shifted such that it now matches the climate in the Napa Valley. The gap has closed to the point that **heat summation is now identical in the two regions**: 3,321 degree days for Ukiah and 3,343 degree days for Napa. Makes one wonder if the next generation of cult wines will be from Mendocino?



55 years of heat summation figures show the convergence of climate in Ukiah and Napa Valleys. Data compiled by Zac Robinson.

Coro Mendocino, one of a kind in America

by Guido Venturi
Venturi Vineyard. First planted in 1946. All reds, mainly Zinfandel. Believes Mendocino grows the best Zin in all of California!



Because it does so well here, I grow mainly Zinfandel, which is the dominant varietal of Coro Mendocino. The Coro Mendocino program includes some of the best wine produced here. It is a unique collaborative effort by a number of our winemakers to create a **class of ultra-premium wines** that showcase the rich heritage and unique characteristics of Mendocino County. This is the first time in U.S. history that winemakers from a region have set blending/aging parameters for a wine distinctive to the area. Made entirely in Mendocino County and exclusively from Mendocino County fruit, these wines share a uniform bottle and label employing a special trademarked logo.

Three upcoming Grower Showcases to meet our growers

by Charlie Barra
Redwood Valley Vineyards. Has proudly worked 61 harvests, never missing one! Currently farming 200 certified organic acres. Taught many growers everything they know...

I'm planning to be at the three Grower Showcases, and I hope you'll come and meet us at one. We want to help you discover more about Mendocino. You'll be able to **meet and talk to dozens of us growers** while tasting the whole range of wines made from Mendocino grapes. Of course, Chardonnay is our most widely planted varietal with 26% of the total acreage. Yet, to quote Russ Parsons in the *L.A. Times*, "Mendocino could well become the home base of the growing Anything-but-Chardonnay club." Between the Redwood Coast and inland valleys, we grow practically every grape under the sun in Mendocino County. Whatever grape varietal you're interested in, we have it available here.

Three opportunities for grape buyers to taste 100 Mendocino wines

Mendocino County Grower Showcases for winemakers, winery owners and grape buyers. Discuss 2007 grape contracts with over 60 growers.

Mendocino - March 14, 2007 – 11 to 3 • Redwood Empire Fairgrounds, Ukiah

Napa - April 5, 2007 – 11 to 3 • Napa Marriott Hotel & Spa, Napa

Sonoma - May 11, 2007 – 11 to 3 • Hyatt Vineyard Creek Hotel, Santa Rosa

Telephone **(707) 468-9886** to make a reservation, including complimentary lunch.

© Mendocino Winegrape and Wine Commission, 2007.

Lemelson Vineyards (Carlton, OR), uses a PGT On-Target electrostatic sprayer to apply wettable sulfur, Serenade, Sonata, solubore, or Humisol (kelp). Applications of pesticides contribute to atmosphereic volatile organic compounds (VOCs) and the subsequent formation of ozone. Pesticides should be selected and used to minimize this problem. Precision technologies, such as electrostatic sprayers, can reduce VOCs from pesticide application by increasing on-target deposition and allowing low rates to achieve pest control.

SUSTAINABLE PRACTICES

Improving AIR quality

BY Joe Browde, Project Manager
California Sustainable Winegrowing Alliance

When Senate Bill 700 became California state law in 2003, it ushered in an era of significant change for California agriculture. The law mandated that agriculture is no longer exempt from provisions of the 1990 Federal Clean Air Act and has resulted in an intense scrutiny of sources of and means to mitigate problematic air emissions from farms, dairies, and other agricultural operations.

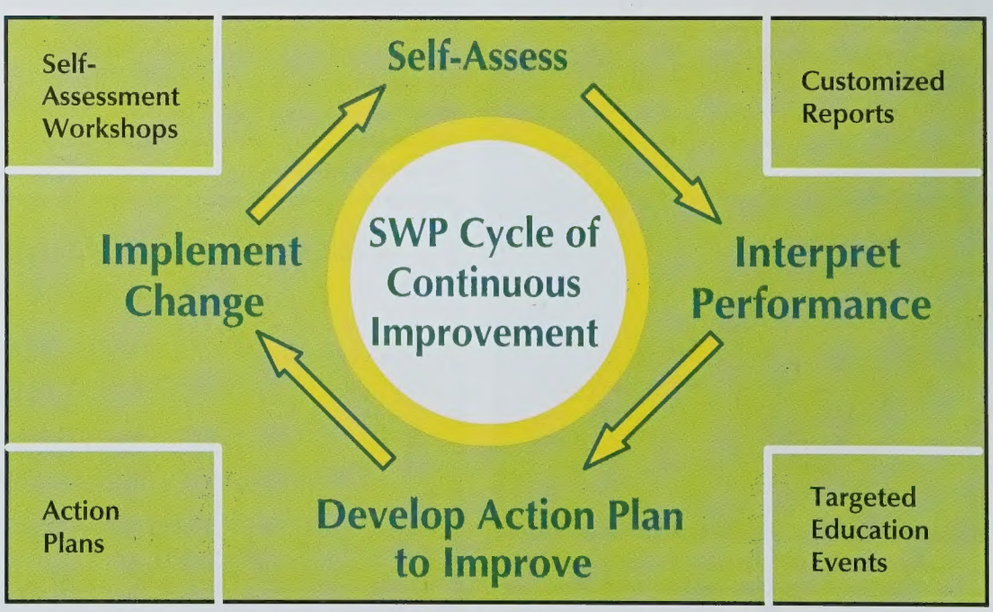
The California Sustainable Winegrowing Alliance (CSWA), through its proactive Sustainable Winegrowing Program, has extended its industry-driven sustainability outreach to growers and vintners to include air quality and practices and technologies that meet and exceed regulatory compliance in reducing air emissions.

Air emissions and agriculture

Two important categories of air emissions affected by agriculture are: 1) the criteria air pollutants and 2) greenhouse gases. The criteria or common air pollutants (Table I) are regulated by the U.S. Environmental Protection Agency (EPA) and the California Air Resources Board (CARB).

The EPA establishes nationwide standards for criteria air pollutants based on human health effects. CARB generally adopts more restrictive standards for these pollutants to meet the requirements of the California Clean Air Act, although current regulations are focused on attaining national standards. Geographic areas in which the level of a criteria air pollutant exceeds national and/or state standards are classified as non-attainment areas.

There are 15 air basins within California that are designated as being in attainment or non-attainment status for each criteria air pollutant. Regional or county air districts associated with non-



The use of equipment for managing vineyard floors can stir up dust and contribute to PM10 problems. Equipment should be selected and operated to minimize dust generation.

attainment areas for one or more pollutants must prepare management plans that detail means for ensuring future compliance with national standards. Regional or county plans are incorporated into the State Implementation Plan submitted to the EPA describing how California will attain and maintain national standards.

Robert Sinskey Vineyards (Napa, CA) uses a HARDI Arrow B11 pneumatic sprayer to apply Serenade and Sonata and a calcium foliar spray, or wettable sulfur and a potassium foliar fertilizer and a seaweed spray like organic trigger. Drift reduction is achieved as the sprayer-spouts direct the air to where it's needed and nowhere else. The amount of air is adjusted according to the growth stage via a two-speed gearbox. The turbine has a higher capacity than actually needed in most occasions that allows the tractor to run at lower rpm and save fuel.

The two criteria pollutants associated with agriculture and non-attainment status in several winegrowing regions in California are particulate matter and ozone.

Airborne particulate matter is a complex mixture of miniscule solid and liquid particles. Particles less than or equal to 10 microns in diameter are known as PM10 and pose serious respiratory and heart-related concerns, because they can migrate past the nose and throat and penetrate the lungs. Ten microns is about one-seventh the diameter of a human hair.

The PM10 spectrum is subdivided into "coarse" and "fine" particles. Coarse particles range between 2.5 and 10 microns and often are produced during crushing or grinding operations.

Most important for winegrowers, however, are fugitive dust particles (such as dust from vineyards or roads) stirred up by wind, vehicles, or equipment.

Fine particles (PM2.5) are less than or equal to 2.5 microns and are directly emitted during combustion of fossil fuels

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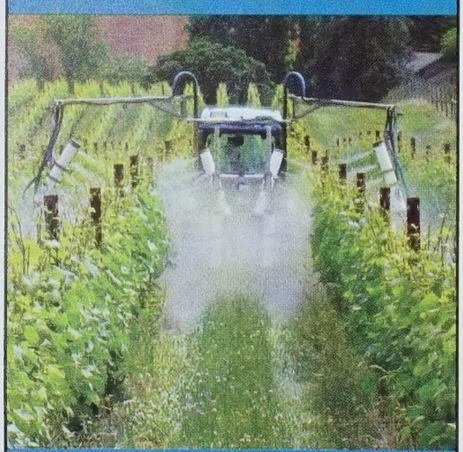

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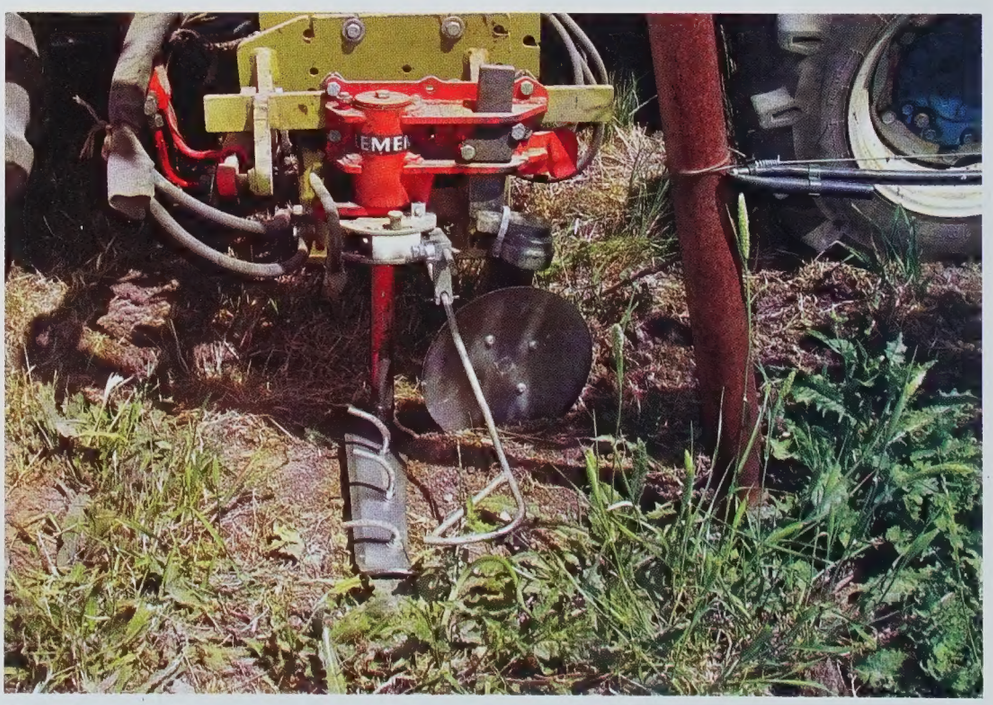
Where appropriate, under-the-vine mowing can adequately suppress vegetation while producing less dust and PM10 than mechanical methods that significantly disturb the soil. However, for total air quality impact, the amount and type of fuel required for equipment operation also should be considered because of emissions of PM2.5, VOCs, NOx, and CO_2.

(especially petroleum diesel) and wood or are produced by atmospheric conversion of gaseous pollutants. PM2.5 exposure can lead to significant health concerns.

Ground-level ozone occurs in the troposphere, the atmospheric layer closest to earth. It is important to distinguish this problematic ozone from the beneficial ozone that provides ultraviolet light protection in the more distant stratosphere.

Ground-level ozone is formed through atmospheric reactions of nitro-



Some tools used for mechanical weed control cause minimal soil disturbance, producing less dust and PM10 than others.

HOW A DREAM ON THE HORIZON BECOMES YOUR PERSONAL VIEW OF REALITY.

American AgCredit has been making real estate loans to the agricultural community for nearly a century, building a legacy of trust and a network of support for our customers.

Not everyone who dreams of owning a vineyard gets there, but the determined ones do.

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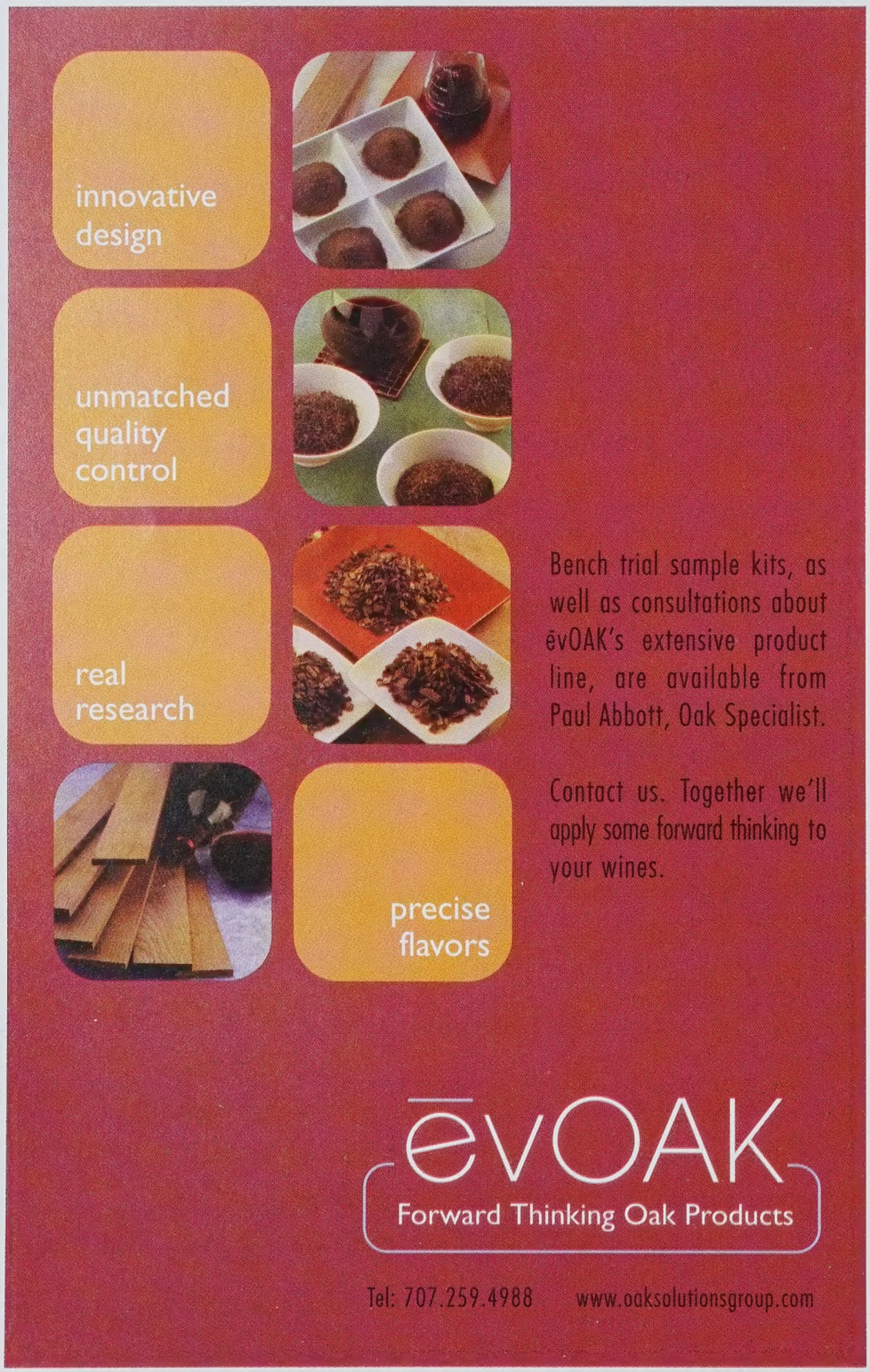
gen oxides (NOx) with volatile organic compounds (VOCs) in the presence of sunlight. NOx are produced during the combustion of fossil fuels, especially petroleum diesel.

Agricultural sources of VOCs include the handling and combustion of fossil fuels, certain pesticides, winery fermentation and storage processes, and livestock production.

The highest concentrations of ground-level ozone occur in the summer and fall during hot and sunny conditions ideal for ozone formation. Ozone is linked to various respiratory ailments. Moreover, ozone can adversely affect crops and other vegetation by decreasing growth and yield and increasing susceptibility to pests and other stresses.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Greenhouse gases

Emissions of greenhouse gases and their effects are high profile issues on the global scale. Although not currently classified as air pollutants nor directly linked with human health issues, carbon dioxide (CO_2) and other greenhouse gases emitted during the combustion of fossil fuels are associated with global warming and related climatic ramifications, such as rising sea levels and altered precipitation patterns.

Some agricultural activities produce greenhouse gases, including burning, soil tillage, livestock production, and excess application of fertilizers. It is essential to note, however, that agriculture can also provide a significant benefit by sequestering CO_2. Grapevines, cover crops, and other vegetation in and around vineyards and wineries fix CO_2 from the air through photosynthesis and store a portion of the carbon in their tissues.

Industry-driven initiatives

The California Sustainable Winegrowing Program began in 2001 as a partnership between members of the winegrowing community to promote sustainable vineyard and winery practices that are sensitive to the environment, responsive to the needs and interests of society-at-large, and economically feasible to implement.

Program leadership is provided by the CSWA, a non-profit organization consisting of leaders from the two key statewide organizations affiliated with California winegrapes and wine — the California Association of Winegrape Growers (CAWG) and the Wine Institute. Technical integrity is ensured by a diverse, 50-member committee of growers and vintners and external partners.

Program funding is provided by the Wine Institute, CAWG, and grants. In-kind contributions of time and expertise from individual growers and vintners, regional organizations, university extension staff and researchers, government agencies,

and other external participants constitute a large proportion of total program costs.

CSWA utilizes a vast partnership network to maintain its cycle of continuous improvement (Figure I), consisting of grower and vintner self-assessment, customized reporting, targeted education, and action planning.

A key element to the program, *The Code of Sustainable Winegrowing Practices Self-Assessment Workbook* (second edition released November 2006), covers a broad range of farming and winemaking practices in 14 chapters and 227 criteria (specific management areas within each chapter) and provides additional educational information and links. Each criteria includes four categories of practices based on increasing sustainability (scale of 1 to 4; 4 is highest).

The program does not involve a third-party certification system, with participants' practices certified against a set of defined standards. Instead, it relies on voluntary involvement and strict confidentiality of individual assessments for purposes of optimizing participation while fostering collective progress along the continuum of sustainability.

To complement self-assessment, the program employs a systematic extension model for advancing grower and vintner performance against statewide benchmarks, such as those published in the *California Wine Community Sustainability Report 2004* and the *California Sustainable Winegrowing Program Progress Report 2006* (reports available at www.sustainablewinegrowing.org).

Implementation of the extension model begins with regional and statewide analyses and interpretation of assessment data collected from growers and vintners. Accordingly, specific management areas (criteria) of strength and for improvement are identified for each winegrowing region. Follow-up targeted education then is prioritized with regional leaders to focus on those areas most needing improvement.

A combination of peer-to-peer education and presentations by technical and regulatory experts is used to deliver information about sustainable practices.

Growers and vintners are encouraged to use the targeted education along with information from the workbook and other sources to develop action plans. Execution of this model for targeting educational needs by region has proven to be a cost-effective method to increase adoption of sustainable practices.

In 2004, CSWA was awarded a National Conservation Innovation Grant by the U.S. Department of Agriculture, beginning a partnership

Table I: The Criteria Air Pollutants (from the California Sustainable Winegrowing Workbook)

Criteria Air Pollutant	Key Sources
Ozone (ground level)	Formed by photochemical reaction involving volatile organic compounds (VOCs) and nitrogen oxides (NOx)
Volatile organic compounds (VOCs)*	Released from handling and combustion of fossil fuels (e.g., diesel, gasoline, oil, coal, natural gas); livestock; solvents, paints, glues, pesticides, and other petroleum-derived products; and respiration by plants and decomposition of organic matter
Nitrogen dioxide	Combustion of fossil fuels (especially petroleum diesel)
Particulate matter (PM10 and PM2.5)	Combustion of wood and fossil fuels (especially petroleum diesel), dust from industrial and agricultural operations and unpaved roadways, some applications of pesticides, and atmospheric conversion of gaseous pollutants
Sulfur dioxide	Combustion of coal and oil
Carbon monoxide	Combustion of fossil fuels, especially during cold temperatures
Lead	Leaded aviation gasoline, paint, smelters, and manufacture of lead storage batteries

*Although not criteria pollutants, VOCs are included because they are important ozone precursors.
Detailed information about the criteria air pollutants and associated human health and environmental effects is at www.epa.gov/oar/oaqps/peg_caa/pegcaa11.html. Glossaries of air pollution terms are at www.arb.ca.gov/html/gloss.htm and www.epa.gov/oar/oaqps/peg_caa/pegcaa10.html.

for applying the cycle of continuous improvement to air and water quality.

Objectives relevant to air protection were to develop criteria and then conduct assessments for air quality, to upgrade the program's assessment and reporting software for online use and reporting, to deliver targeted education to growers about practices to protect air, and to measure progress in the adoption of recommended practices.

Assessment criteria to improve air quality

The CSWA and partners developed an Air Quality chapter for the second edition of the self-assessment workbook that includes 10 criteria, 17 sidebars with associated educational information, numerous resource links, and other information. Growers and vintners are using this chapter to assess their performance in minimizing particulate matter, ozone precursors (NOx and VOCs), and greenhouse gases.

The 10 criteria and relevant practices for attaining high marks in sustainability are summarized below. California growers and vintners can obtain more information and guidelines by actively participating in the program (see www.sustainablewinegrowing.org) and using the workbook.

1. Planning, monitoring, goals, and results

The establishment and execution of vineyard and/or winery plans to achieve measurable reductions in problematic emissions is key. Growers and vintners achieving higher levels of sustainability must have specific knowledge of emission sources and types, regularly review updated information on air quality, monitor emission quantities, conduct pertinent employee training, and track emission reductions against annual goals.

2. Vineyard floor management

Dust stirred up from the vineyard floor is a source of PM10. To address some of the poorest air quality in California and reduce PM10, growers in the San Joaquin Valley with 100 or more acres of continuous, or adjacent, farmland must prepare and implement

Table II: Estimated VOC Content by Pesticide Formulation* (from the California Sustainable Winegrowing Workbook)

Formulation Category	Emission Potential
Pressurized products	100.00
Emulsifiable concentrates	39.15
Solution/liquid (ready to use)	7.30
Liquid concentrate	5.71
Suspension	5.71
Pellet/tablet/cake/briquet	5.18
Flowable concentrate	4.80
Granular/flake	3.70
Oil	3.47
Wettable powder	1.85
Dust/powder	1.53
Soluble powder	1.15
Dry flowable	1.02

*The emission potential is that percentage of the product assumed to potentially contribute to atmospheric VOCs. Understanding the relationship of estimated laboratory emission potentials displayed here to field emission rates and subsequent ozone formation is evolving. Nonetheless, growers should be alert to current understandings and consider limiting use of pesticides with higher estimated potentials, e.g., fumigants and emulsifiable concentrates. Additional information about VOCs and pesticides is available at www.cdpr.ca.gov/docs/pur/vocproj/vocmenu.htm.

Conservation Management Practices (CMPs) Plans (http://valleyair.org/farmpermits/updates/cmp_handbook.pdf) as mandated by the San Joaquin Valley Air Pollution Control District's Rule-4550.

To achieve the highest level of sustainability, growers from all winegrowing regions must exceed this regional requirement by implementing comprehensive plans that must include permanent or no-till cover crops, no or minimally disruptive under-vine tillage, and other soil conservation practices (such as maintaining unfarmed vegetative areas, planting trees and hedgerows, and minimizing equipment passes).

3. Unpaved surfaces — roadways and equipment staging areas

Unpaved surfaces in and around vineyards and wineries are sources of

How does "Balanced Soil Fertility" apply to winegrapes?

The ideal soil is considered to be composed of 45% minerals, 5% humus, and 50% pore space. Ideally, 50% water and 50% air occupy that pore space. In addition, the pore space (containing the proper amount of air and water), also must provide the correct environment for all types of living organisms necessary to help supply the needs of growing roots in that soil and for vines growing aboveground.

Essentially, the winegrape-balanced soil fertility model utilizes soil chemistry to affect soil physics, which determines the environment for the biology of the soil. The soil audit, using a specifically developed set of soil testing procedures adapted for identifying the fertility characteristics of top-producing soils for growing winegrapes to determine and correct the soil's mineral content, provides the means to measure and supply the needed chemistry for each particular soil.

It is the chemical make-up of each soil that determines its physical structure.When a soil has the correct chemistry, the physics of that soil will also be correctly achieved. When the chemistry and physics are right, the environment for the biology will also be most ideal unless something is done to seriously compact that soil. That is why so much emphasis is placed on achieving the exact level for each nutrient, based on the specific requirements of every different soil, and avoiding the practices that can help lead to soil compaction.

Soil nutrients are supplied based on any deficiencies or excesses. When there is too much of one element in the soil, there will be too little of something else. Supplying what is missing in terms of nutrients is the first key to controlling any excesses in that soil.

That is why this program emphasizes feeding the soil and let the soil feed the plants. When the soil contains the correct chemistry, grapevines will be able to acquire the nutrients that soil has the ability to supply, in the proper amounts. Using the correct type of fertilizer is most important, and must be accurately ascertained by testing procedures. The approach is to use fertilizers that increase nutrient levels in the soil. Too many fertilizers are plant feeders, only remaining in a form useable by plants for a short time period. It is far better to use fertilizers that feed the soil and let the soil feed the plant naturally. Such materials are applied in order to build nutrient levels, thus keeping in an available form what is not used up by the current crop, for use by the next crop.

You cannot manage what you cannot measure. Using this system of testing soil and treating to balance the soil nutrients, even maintaining necessary trace element levels in the soil takes on greater significance. But those elements can only work properly after being correctly selected and adequately supplied. They only work in exactly the way they should when the needed primary and secondary elements have been accurately determined and supplied.

This is the basis for what has come to be called a "balanced soil fertility" program. This system was developed for balanced nutrient feeding, even to the point of measuring nutrient increases pound-for-pound as they are added and become available for plant use.

This program of balancing soil nutrients to encourage the proper uptake of needed elements is presently being used successfully on all types of grapes. With such emphasis placed on quality in the growing of winegrapes, the program has become well accepted and is now being implemented and utilized by a larger group of very successful vineyards from coast to coast in the U.S., and in several other countries also.

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PM10. Growers and vintners reaching higher levels of sustainability must implement soil conservation plans that include effectively timed applications of water or regulatory compliant anti-dust materials and/or more permanent solutions, such as seeding or paving their roads and equipment yards. Furthermore, speed and travel on these roads are reduced and employees are trained to minimize dust creation.

4. Irrigation

Growers and vintners need to be aware of relationships between irrigation and air emissions. Much energy is used to pump water, resulting in PM2.5, NOx, VOCs, and CO_2 in amounts that vary with the energy expenditure and source of energy.

Practitioners realizing significant reductions in problematic emissions proactively design and manage irrigation systems to expend the least amount of energy and water to meet yield and quality goals. This includes optimizing the efficiency of the pumping plant; maintaining operational efficiency of lines, filters, drip emitters, and other system components; and conserving water (through deficit-irrigation, for example).

Additional reductions are realized by adjustments made at the power source. This includes replacing or retrofitting old diesel engines with cleaner-burning technology, using lower emission fuels (such as biodiesel, propane, or natural gas), or installing electric motors.

The cost of diesel engine replacement may be shared by the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) through grants from its Environmental Quality Incentives Program (EQIP) and/or by local California air districts through grants from the Carl Moyer Memorial Air Quality Standards Attainment Program.

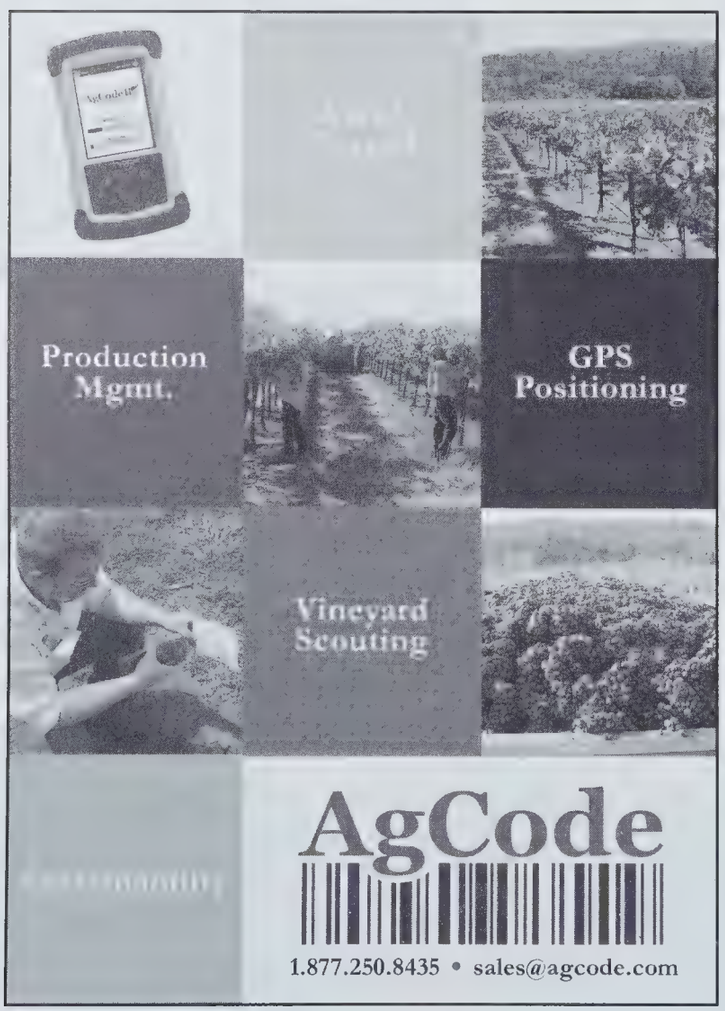
EQIP cost-share information about diesel engine replacement and other practices to protect air is available at www.ca.usda.gov/programs/eqip/2007/stateprioritie s2007.html.

In order to achieve optimum sustainability, growers and vintners incorporate these cost-efficient and environmentally sensitive measures to reduce energy expenditure and air emissions during irrigation.

5. Pest management strategy

Growers using more sustainable approaches include elements of air protection in their pest management programs. Integrated strategies that first emphasize biological and cultural tactics to maintain pests at tolerable levels generally will reduce tractor passes and pesticide applications.

By making fewer tractor passes, growers reduce soil disturbance and



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PM10 production and limit fuel consumption and emissions of PM2.5, NOx, VOCs, and CO_2. Growers achieving higher levels of sustainability also base decisions for pesticide applications on economic thresholds and/or weather-based decision indices.

6. Pesticide stewardship

Many active and inert ingredients in pesticide products are sources of VOCs. Moreover, inappropriate applications of some pesticides (such as sulfur dust) can result in drift and PM10 concerns.

Each pesticide product has a different capacity to volatilize and produce VOCs and each VOC varies in its potential to form ozone. These processes are also affected by meteorological (air temperature, light intensity, and relative humidity) and physiochemical (pesticide formulation, spray drift potential, spray retention and absorption by foliage or soil) variables.

Despite this complexity, growers can take general steps to limit VOCs from pesticides by choosing low VOC products, restricting applications and rates, and ensuring that a high proportion of the applied material reaches the intended target. Excellent efficacy at low rates often is achieved by the use of precision technologies such as electrostatic canopy sprayers or shielded vineyard floor sprayers with remote sensors that enhance on-target deposition, decreasing drift and the potential for increased volatilization.

To achieve higher levels of sustainability, growers must avoid use of pesticide formulations with higher estimated VOC contents (Table II) and follow recommended practices detailed in the workbook to reduce pesticide use, drift, and PM10.

7. Agricultural/winery chemicals and materials

Besides pesticides, other chemicals and materials used by growers and vintners can emit VOCs (such as solvents, paints, and glues). Although used decreasingly, ozone-depleting substances include chlorofluorocarbons, hydrochlorofluorocarbons, halons,

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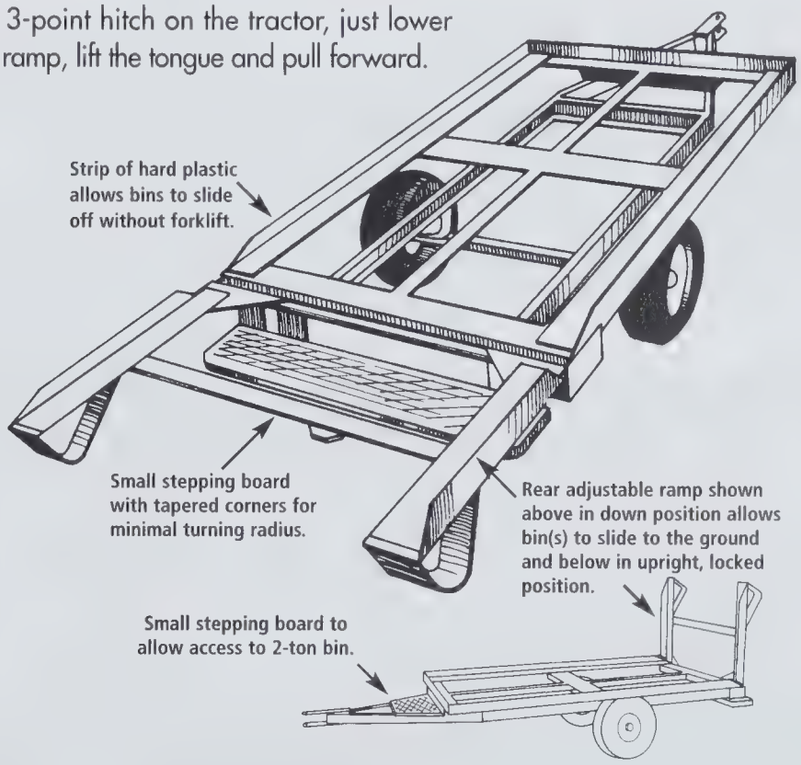
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methyl bromide, carbon tetrachloride, and methyl chloroform.

Growers and vintners implementing higher levels of sustainability execute a plan for chemical acquisition and use that considers and minimizes use of products with higher VOC content, proven or suspected potential to deplete ozone, and greater toxicity.

8. Energy sources/efficiency

Improvements in energy efficiency and the use of alternative energy sources impact air quality and costs. Growers and vintners exhibiting increased sustainability consciously carry out cost-effective plans to conserve electricity; optimize efficiency of power equipment; track and limit fuel consumption; and use biodiesel, solar systems, or other options that reduce reliance on fossil fuels and decrease emissions of air pollutants and greenhouse gases.

9. Transportation

Fuel consumed during transportation can represent a significant portion of the energy budget and air quality footprint. Environmentally and cost-conscious growers and vintners consider and employ means to limit business travel (such as car, truck, airline, and train), set emission reduction goals for transportation, and track and measure progress. Higher levels of sustainable performance also include pertinent employee training.

10. Agricultural burning

Some growers continue to burn prunings, removed vines, and organic waste, thereby increasing problematic emissions. To achieve optimum sustainability, no organic waste is burned in a vineyard and extracted vines and prunings are chipped and utilized as mulch or compost or processed to generate energy. The most proactive growers lead outreach to educate peers about alternatives to burning.

To address poor air quality in the Central Valley, the San Joaquin Valley Unified Air Pollution Control District will prohibit burning of most categories of agricultural waste (including removed vines and prunings) by 2010.

No vineyard stakes or end-posts treated with the preservative chromated copper arsenate can be burned or chipped but must be disposed at certified Class II or specified Class III composite-lined landfills. Growers in the San Joaquin Valley can check with their local NRCS office about cost-sharing for treated wood disposal.

Pairing self-assessment with targeted education

Approximately 120 growers and vintners have already assessed their

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performance against the 10 criteria in the Air Quality chapter. Many of these participants farm within the San Joaquin Valley, an important nonattainment area for particulate matter and ozone.

Use of the second edition of *The Code of Sustainable Winegrowing Practices Self-Assessment Workbook* and the new online system for assessment and customized reporting will increase self-assessments for air quality, leading to needed targeted education and action plan development.

Numerous education events (field days at demonstration vineyards, workshops, and seminars) have already been initiated across California's winegrowing regions to address criteria and practices suggested in the Air Quality chapter.

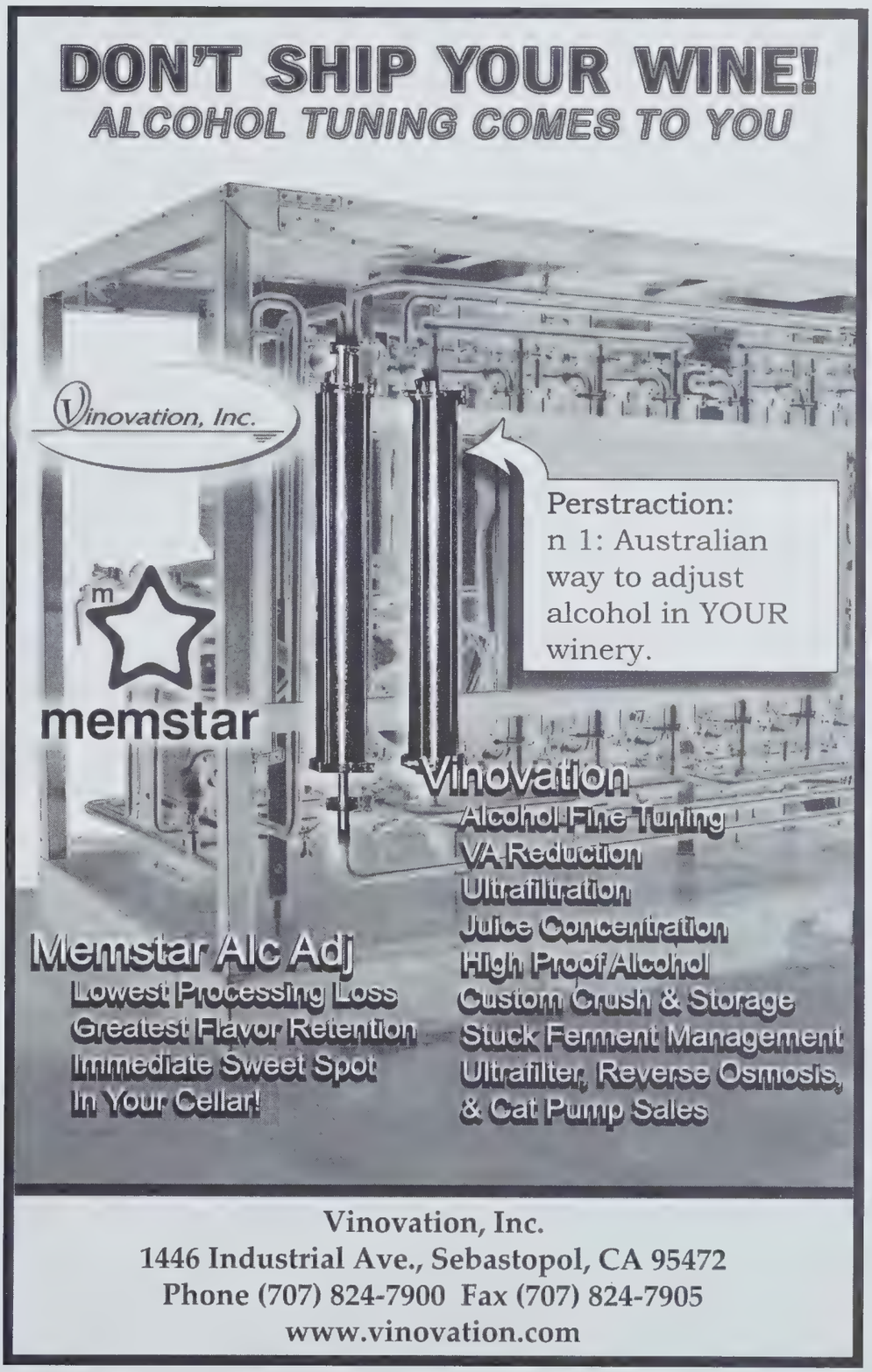
Partners extending information include experienced growers and vintners, NRCS, Sustainable Conservation, University of California Cooperative Extension, California State University, farm bureaus, private companies, CARB, and the California Department of Pesticide Regulation.

Topics have included applicable laws and regulations; road design and maintenance; energy efficiency; alternative energy sources (such as biodiesel and solar); low-emission engines; carbon sequestration; diesel engine upgrades and conversions; alternatives to burning; customized cover cropping and other vegetative enhancements; low-drift and targeted sprayers; environmentally friendly weed and floor management equipment; integrated pest management tactics and pesticide characteristics; and incentive programs (such as EQIP) for initiating protective practices.

Summary

The CSWA continues to implement the interrelated elements of its cycle of continuous improvement to protect and improve air quality and increase sustainable winegrowing. Collected assessment data will be used to track statewide and regional performance, set goals, and prioritize needs for follow-up targeted education.

Future publications will report progress in the adoption of practices for mitigating emissions of particulate matter, ozone precursors, and greenhouse gases. Through the Sustainable Winegrowing Program, CSWA and the California winegrowing community demonstrates its leadership in sustainable agriculture by balancing the economics of producing exceptional grapes and wine with high standards for environmental quality, human health, and social responsibility. ■



BLAME THE VINEYARD? BLAME THE WINERY?

Many common defects of wine and their sources

BY Linda F. Bisson,
Department of Viticulture & Enology,
University of California, Davis

Production of wine is a balance between forces of nature. In large part, the overall character of a finished wine is dictated by the nature of grapes delivered to the winery. Certain factors in the vineyard are constant and others are dependent upon seasonal variation.

Elements of vineyard soil composition and topography do not vary from year to year, and the genetic constitution of a vine is also a constant. Weather, rainfall, disease pressure, soil amendments and other viticultural practices all can vary with each vintage.

Grapevines can respond in different ways to different environmental circumstances, so the expression of the genetic constitution of the grapes can also vary and impact composition at harvest. The grower's goal is to optimize these forces to produce grapes of desired quality. The winemaker must then direct the microbial conversion of grape must into wine and guide the chemical reactions that create the qualities of the final product.

Through winemaking, a winemaker is able to influence grape composition but is constrained by the initial composition of the grapes. It can be challenging to predict the outcome of the microbial transformation of grapes into wine, and practices that enhance one wine may worsen another. Enological decisions can be just as important as those made in the vineyard.

When a wine fails to live up to the potential of its region or style, it is important to understand the cause of the problem. There are chronic problems that can arise even under the best of circumstances.

[Edited from presentation to Southwest Regional Wine & Grape Conference, February 24–25, 2006]

The most common wine defects observed in New World commercial production today are listed in Table I. The cause of each will be considered. The problems are not listed in any particular order since their occurrence and impact will vary by vineyard location and wine style being produced.

Table I: Top Ten Defects in Commercial Wines

Hydrogen sulfide
Acetate/ethyl acetate/microbial spoilage
Persistence of upripe characters
Loss of color
Appearance of an off-color
Haze in bottle
TCA, Trichloro and other anisoles
Thin mouth feel
Persistence of harsh tannins
Atypical ageing characters

Hydrogen sulfide and other sulfur volatiles

Volatile sulfur compounds are produced by yeast during fermentation as a consequence of natural metabolic reactions. Some yeast strains show a strong tendency to produce sulfides, while others do not. The fermentation environment, particularly nitrogen level of the fermentation, strongly affects the appearance of these characters.

There is also a viticultural component. If sulfur dusting or sulfur-containing fungicide or pesticide are applied too close to harvest, they will lead to the appearance of sulfide in a wine. Yeast activity is necessary to establish the correct redox status for the spontaneous chemical reaction that reduces sulfur to sulfide to occur, and just about any yeast will do.

Wineries having chronic problems with sulfides need to consider both possibilities. If it is a problem with the yeast strain, a new yeast strain should be selected or more careful attention paid to nutritional needs of the current yeast. If vineyard spray practices are responsible for the problem, those practices must be adjusted.

When hydrogen sulfide is produced early in fermentation, it can often be driven off by the carbon dioxide produced by the yeast. However, this does not always occur, and some sulfide may be chemically sequestered in non-volatile forms only to return with a vengeance later on.

Sulfides can also be produced late in fermentation, as the wine is ageing on yeast lees. If this happens, it is imperative that the wine be removed from the lees immediately as it will only get worse.

Volatile sulfur problems may not be due to free hydrogen sulfide but instead may be caused by a different chemical form. Disulfides (diethyl disulfide [DEDS] and dimethyl disulfide [DMDS]) require reduction of the disulfide linkage in order for copper addition to be effective.

Removing these forms of volatile sulfur may first require reducing the compound back to a reactive mono-sulfide, which can be accomplished by an ascorbate treatment followed by or simultaneously with a copper addition and allowing sufficient time for the chemical reaction to occur. Sometimes even this is not effective, and the wine must be stripped of off-volatiles, which means that some positive characters will also be lost. As a result, stripping should be only thought of as a last resort.

Acetate/ethyl acetate/ microbial spoilage

If grapes arriving at the winery are sound, free of obvious rot and infection, a microbial spoilage problem is uniquely one of inadequate winery sanitation and monitoring of the wine. The natural end product of the fermentation of grape material is not wine but vinegar, and it is the duty of the winemaker to make sure this final conversion does not occur.

Astute use of anti-microbials — such as sulfur dioxide, lysozyme, and velcorin — along with limiting oxygen exposure of the wine and topping off,

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and inoculation with well-characterized yeast strains and malolactic bacteria should be sufficient to protect the wine against spoilage microbes. However, these practices sometimes conflict with winemaking style and could prevent the evolution of desired wine characters.

The winemaker must achieve a balance between protection and constriction of a wine. In addition, microbial characters are a key component of some wine profiles and development of these characters must be allowed to occur.

New research is demonstrating the importance of secondary chemical reactions of microbial metabolites in the evolution of varietal character and wine complexity and quality.

What occurs, of course, depends upon the starting composition of the grapes, and microbes that positively impact one variety or wine-type may ruin another. Some winemakers feel that a little bit of acetic acid is positive in a wine as it enhances the perception of other characters.

Some consumers actually like a little ethyl acetate, which is variably described as "nail polish remover" or "glue." *Brettanomyces* metabolism of grape phenolics results in the appearance of a wide array of aromas and flavors. In some regions, this evolution of characters is believed to be an essential expression of that region's terroir.

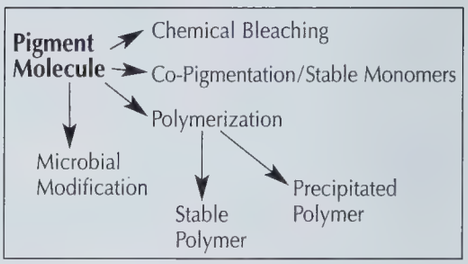

Figure I: Fates of Anthocyanin Pigment Molecules

Persistence of unripe characters

Vegetal characters in wine are often reminiscent of unripe fruit and can become dominant as the wine ages. These characters clearly come in with the grapes at harvest and, short of thermovinification (a short-time high-heat treatment of juice or must), few options are available to winemakers to reduce or mask the presence of these compounds. Their presence in the wine must therefore be addressed by vineyard practices.

Extended hang time has arisen as one means to assure ripe flavors are present and to reduce the influence of persistent vegetal characters. The belief is that the longer grapes are on the vines, the lower the concentration of these components will be. There is some analytical support to this belief as these characters are indeed high in unripe fruit and diminish post-veraison, but in some cases the concentration appears to level out or actually increase later in ripening.

Recent research in the Viticulture & Enology Department at UC Davis, suggests that the root system of a vine and

the soil environment late in the season may be key factors in the persistence of these characters and that canopy management practices will have only a limited impact.

The practice of letting grapes hang to reach proper maturity also has as a drawback of increasing sugar. Resulting ethanol levels lead to wines that may be out of balance with respect to ethanol and acidity. This can be addressed somewhat by reducing the sugar level through water addition and adjusting pH and acidity.

Loss of color

Loss of color is obviously a problem unique to red wines. During maturation, pigments undergo various chemical changes, including polymerization (Figure I). Some of these changes lead to a stabilization of a color form and others lead to loss of color.

What happens in a given wine is dependent upon the pH, SO_2 level, concentration of reactants (anthocyanins and other phenolic compounds), temperature, oxygen level, redox status of the wine, presence of laccase or other enzymes, and the yeast strain present. In other words, changes in color can be difficult to predict.

Wine color is dependent upon several different types of interactions in addition to the level of anthocyanin monomers (unreacted anthocyanins). Anthocyanins are the major pigmented molecules found in wine. For most red varietals, the anthocyanins are localized in the cell wall of the berry from which they must be extracted during processing.

Anthocyanins can be bound or associated with other phenolic compounds in the wine. This association is freely reversible, but some of the complexes formed have a more intense color than that of the free anthocyanin. These complexes are called co-pigments, and the phenomenon is termed co-pigmentation.

In some varieties, co-pigments appear to be stable throughout the life of the wine and are therefore important contributors to color. In other cases, stable color is due to the development of small polymerized pigments. In this case, the interaction between the anthocyanin and other compounds is much stronger and can be thought of as permanent.

If the polymer becomes too large, it will drop out of solution during ageing and the color contribution will be lost. The chemistry of this process is complex and dependent upon what types of reactants are present and how the wine is being aged.

Finally, the yeast affect wine color via multiple processes. Yeast can contribute to the stabilization of short polymerized pigments, although exactly how they do this is unknown. Yeast also seem to be able to metabolize the pigment molecules, removing or adding components via enzymatic reactions. The yeast can also bind to tannins and polymerized pigments, and when the yeast are removed from the wine, the pigments will be stripped with them.

Some of these yeast effects stabilize color and some can remove it, so what happens may be difficult to predict. We found that yeast behave differently depending upon the starting varieties, and the same strain may stabilize color in one variety but result in its loss from another.

Sulfite also affects color. Sulfite can bind to anthocyanin molecules, which results in a loss of color. This binding is reversible, so as sulfite is lost from the fermentation, color can come back. The sulfite addition forms of anthocyanin behave differently chemically than forms that are not bound to SO_2, so use of sulfite can impact what type of stable color forms eventually develop.

The color of a wine is dependent upon choices made both in the vineyard and in the winery. Some varieties, such as Pinot Noir, have anthocyanins that preferentially form unstable forms of pigment, whereas others, such as Cabernet Sauvignon, have a tendency to be much more stable.

Key winery practices that impact color are the heat of fermentation (impacts anthocyanin extraction and extraction of compounds interacting

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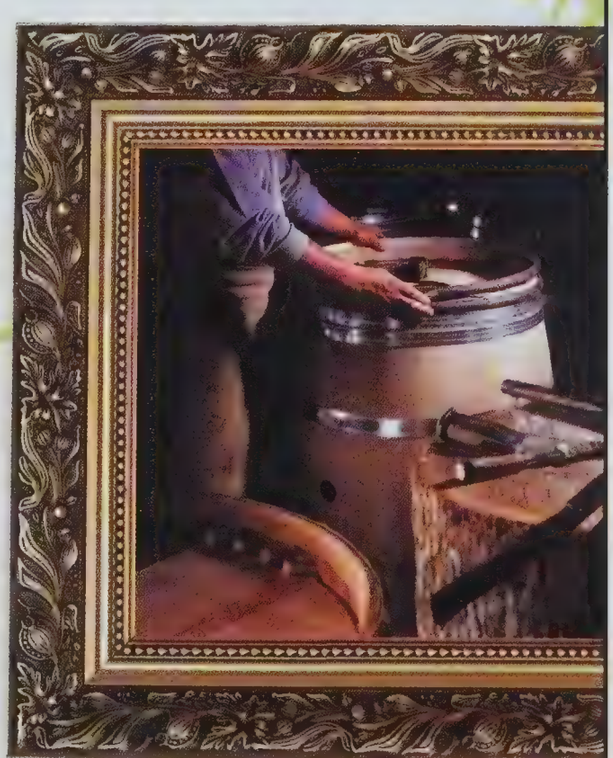

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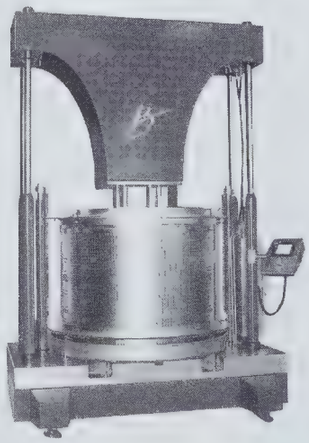
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with anthocyanin), extended maceration (impacts extraction of things that bind anthocyanins), yeast strain used, conditions and length of ageing of the wine.

Appearance of an off-color

Off-color is a problem unique to white wines. Although these same colors can develop in red wines, they are not problematic as they do not negatively impact the existing color and may instead add nuances to it. The off-colors that can appear are pink, orange, and various shades of brown. These compounds arise from the chemical oxidation of phenolic precursor compounds present in the grapes at harvest.

In some cases, their formation is accelerated by laccase produced by *Botrytis*. Other molds can also have an effect on the development of dark colors in white wines but have been less well-studied. Control of molds in the vineyard can be important in limiting the appearance of these colors.

Use of sulfite or limiting exposure to oxygen can also be useful. Some wineries practice "hyperoxidation" of the juice, which means aerating it heavily to force the formation of the off-color (usually brown in this case), then removing the brown color either by using a fining agent or by letting it bind to the outside surface of the yeast cells and letting the yeast serve as a fining agent.

Some winemakers find that SO_2 alone is not sufficient to prevent oxidation reactions of phenolic compounds, but that if a vigorous yeast strain is used, the yeast will effectively strip the oxygen from the wine providing a natural protection against off-color development. Of course this works only as long as the yeast are active.

Other practices are to heat the wine to inactivate any oxidizing enzymes, either from the grapes or from molds, then to add bentonite to remove the protein. This works well at preventing off-color formation but can lead to other problems. Another approach is to use a compound like PVPP to remove phenolic compounds, so they are not present to form an off-color in the first place.

Haze in the bottle

Another problem is development of a haze or cloudiness in the bottle. This is only a visual defect, but one that is off-putting to most consumers. Hazes can be dispersed or particulate but are

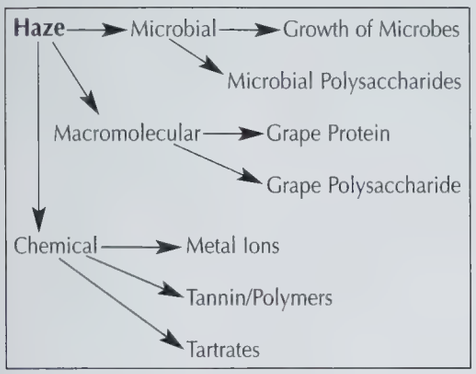

Figure II: Types of wine haze

never welcome no matter the form. Hazes can come from different sources (see Figure II). Hazes may be caused by microbial growth in the bottle. This would occur if the malolactic fermentation has not been completed prior to bottling or if there is residual sugar at the time of bottling and the wine is not sterile-filtered and sterilely bottled.

It is important that sterile-filtered wine be prevented from re-inoculation post-filtration and prior to bottling. It only takes one cell to eventually build up to a visible population in the bottle, especially if sugar or other nutrients remain in the wine.

It is especially important that when sugar is added to a wine just prior to bottling, in the form of concentrate for example, that the concentrate also be free of microbes. If it is not, the yeast that may be present will happily grow in bottled wine.

Presence of sulfites can also limit growth in the bottle – limit, but not necessarily prevent. In many cases, sulfite works by inhibiting microbes, not by killing them. Some are able to bide their time and wait for sulfite levels to be reduced by other means and then they will resume growth.

Haze may also come from other sources. Macro-molecules, proteins, and polysaccharides can cause a haze if they lose solubility in the wine. This happens with proteins when they associate with each other and form a complex large enough to be visible. This is a slow process that occurs over time, depending upon the wine temperature. It can happen in the bottle, too.

Protein aggregation is stimulated by high temperature, since this denatures the proteins and exposes more sites by which they can interact. If the consumer heats a wine (by leaving it in the trunk of the car), a haze can form. Most

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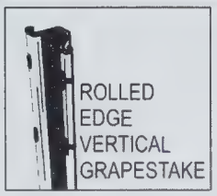

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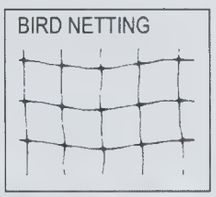

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winemakers deal with this possibility by using fining agents to strip the protein from a wine.

Proteins that cause haze come from grapes. Grape proteins that have been implicated as causing haze are proteins that are involved in the pathogen response, so grapes under higher disease pressure may be at greater risk for developing a protein haze.

Polysaccharides produce a similar type of haze but, in this case, it is sugar molecules that are interacting with each other. This interaction is driven by the chemical composition of the wine. Ethanol is a key factor. Ethanol can cause water molecules to dissociate from the surface of the polysaccharides, so they are more attracted to each other and can form bonds with each other. As with the proteins, when these complexes get large enough, they are visible.

Unfortunately, fining agents that are effectively able to strip out polysaccharides are not available. The polysaccharides of wine can come either from microbes or from the grapes themselves.

Proteins and polysaccharides can interact with each other, and sometimes this stabilizes each against forming large aggregates. Proteins made from yeast that contain both protein and sugar groups can stabilize haze precursors also. This is called the yeast "haze protection factor."

Wine hazes can also be chemical in origin. If metal ions are present, a metal ion "casse" can form. This is very rare today, as wine is no longer made in containers leading to the pick-up of high metal ion content.

Tartrate is an acid species found in wine that can crystallize if conditions are right. It is a negatively-charged anion. If positively-charged counter-ions are present, they can neutralize each other, leading to crystal formation and the loss of solubility of the aggregate.

Tartrate crystallization is stimulated at low temperature, so one can super-chill a wine and allow tartrates to crystallize out of the wine. If this is not done, tartrates may form in the bottle and have the appearance of shards of glass. New World consumers are not used to having tartrates in wine and consider the presence of these crystals to be a defect.

Tannin, or polymerized polyphenolic compounds, can also form in wine and become large enough to be visible. Interactions of tannin with proteins and/or polysaccharides can produce a large complex molecule. Tannin precipitation usually occurs during ageing, but can occur in the bottle where it often appears as a lacquer on the inside of a bottle, typically pigmented. Whatever the source of the haze, many consumers consider it an indication of a defective wine.

TCA — Trichloro and other anisoles

Trichloroanisole is known as the "corked" character and is reminiscent of a moldy dishrag. There is a wide

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variation in people's ability to detect TCA, so levels that are intense to some consumers may not be detected by others. These compounds come from the methylation of chlorinated phenols.

Chlorinated phenols can come from several sources: from the metabolism of mold on bleached corks, from the metabolism of winery organisms presented with both chlorine as a sanitizing agent and phenolic compounds from wine or from pentachlorophenols used to treat wood used in winery construction, from processing of barrels (again via mold activity), and from grapes themselves if they have been picked and shipped in wooden containers that were treated with chlorine and that had mold growth on the surface of the container.

If it is known that corks are the source of the problem, seek a new cork supplier! Oftentimes it is the winery itself that is the source of TCA that is then being absorbed into the wine as it ages in the barrel. This can be eliminated by not using chlorine as a sanitizing agent, but if chlorine has been used for years in the winery, chlorinated compounds may have built up and be a continued source of chloroanisoles even after use of chlorine has been stopped.

In some cases, it has been necessary to remove wood from the winery to eliminate this point-source of chloroanisoles. If wood used in the winery construction was treated with pentachlorophenol, this can be the source of TCA irrespective of use of chlorine as a sanitizing agent. Bacteria and molds can also be the source of TCA.

Thin mouth feel

Another problem that can occur is the lack of texture, smoothness, or mouth feel in a wine. Such wines are often described as "watery" or "thin." This problem is usually accompanied by a lack of flavor by mouth and often by a metallic taste. It is not yet known for certain what components of wine are most important for mouth feel.

Wines that are aged on the yeast lees have better mouth feel than those that are not, but the reason for this is not clear. Research has suggested that glycerol, peptides and proteins, and lipids are all important components of mouth feel, but often the concentration-level of these compounds needed to achieve an effect exceed those normally found in wine. These mainly develop as a consequence of microbial activity in combination with other practices, such as aeration of a wine as it ages. Fining and filtration are also thought to negatively impact mouth feel, but it is not clear that they do.

Mouth feel is affected by the balance between ethanol and acidity and tannin levels. It is a complex phenomenon that has not been sufficiently studied. It is dependent upon both the composition of the grapes at harvest and the metabolic

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activities of microbes and processing decisions made by the winemaker.

Persistence of harsh tannins

Tannins can be responsible for the astringency of wine and are polymers of naturally occurring polyphenolic compounds. Tannins are derived from condensation reactions between flavonoids, catechins, and proanthocyanidins.

Tannin-precursors can come from seeds and from the rest of the grape. Ripeness of the seeds at harvest and how affected the seeds are by processing decisions can impact tannin levels and the type of tannin in the wine.

There is a lot of interest in understanding how tannins form and the impact of specific classes of tannins on wine quality. Harsh tannins are those that are very astringent and unpleasant, inducing a strong sensation of dryness by mouth.

There are different descriptors to describe tannins, such as soft (good), hard (not good), green (not good), round (good), mature (good), young (not good), persistent (not good), or chalky (not good). It is not clear how the sensations of tannins differ and how the chemical form fits these various descriptors and if these descriptors are even valid.

Tannins bind proteins in the mouth, and this interaction is responsible for the sensation. Recent development of protein-binding tannin assays is beginning to clarify how tannins mature and what the different forms are. It was thought that tannin management was exclusively a winemaking problem, but it now appears that tannin management begins in the vineyard.

Tannin development is thought to be influenced by environmental factors, and some winemakers believe irrigation near harvest is important to mature tannins in the fruit.

Tannin development is also impacted by oxygen exposure of the must or wine and practices that enhance extraction of grape components. Tannins are a component of mouth feel, and the perception of the tannin is influenced by a wine's composition. Tannin level and form can be adjusted by fining or by ageing strategies. Given sufficient time, tannins can condense to large forms that will precipitate from the wine.

Atypical ageing character

Atypical ageing initially referred to the appearance of a foxy character in vinifera wines, but this term now refers to a broader problem, the rapid loss of varietal characters in wines leading to an appearance of underlying negative aromatic compounds, such as the foxy character or floor polish. This is primarily found in white wines and is thought to be a symptom of vine stress.

It is not yet possible to prevent the loss of varietal character by winery practices, and the solution lies in the vineyard. It is not clear whether the loss of varietal character is caused by a deficiency in accumulation of these varietal compounds in the grapes while on the vine or due to decreased stability caused by the presence of elevated levels of enzymes or other chemical reactants that will degrade or lead to loss of these varietal characters.

The loss of fruit character can often be rapid and unpredictable during wine ageing. Once the characters are gone, they do not return — this is a true loss of characters, not a masking caused by the evolution of the atypical ageing traits.

Conclusions

Many major defects or detractors from desired qualities in wine have origins in both vineyard and winery. More often than not, winemaking cannot correct problems generated in the vineyard. In fact, winery practices and decisions may even enhance a negative character present in the grapes at the time of harvest.

The chemistry of wine evolution is complex and many factors influencing final wine composition are largely unknown. Greater control over microbial populations is possible, but the level of intervention required may conflict with wine style. At best, the grapegrower and winemaker are merely guiding the forces of nature that actually control creation of wine. ■

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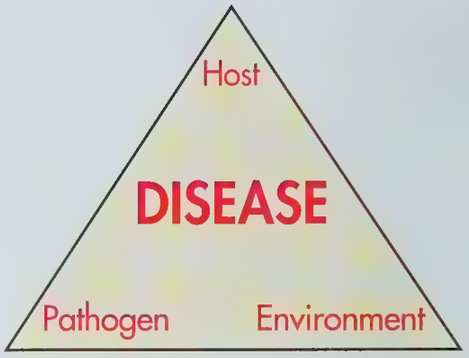
Understanding and controlling Botrytis



BY **Wayne F. Wilcox**
Department of Plant Pathology,
Cornell University,
NY State Agricultural Experiment Station,
Geneva, NY

Botrytis bunch rot (BBR) occurs sporadically in Mediterranean climates such as California, yet it can still cause significant crop losses in a challenging year, as 2006 so rudely demonstrated. *Botrytis* is a chronic problem in New York, as it is in other humid growing regions of the world. Therefore, we have devoted considerable effort to better understanding its biology and control.

Some of this research has been supported by the California wine industry through the American Vineyard Foundation, in addition to the U.S. Department of Agriculture Viticulture Consortium-East. Such support is gratefully acknowledged.

Disease biology

BBR is an amazingly complex disease, and is a virtual "poster child" for the concept of the so-called "disease triangle," the idea that plant diseases are governed by multiple three-way interactions among the host (grapevine), the environment, and the causal pathogen (the *Botrytis* fungus).

Many of these interactions are poorly understood. This is fascinating to a research plant pathologist, but frustrating to a vineyard manager, who needs to determine when intensive disease control is necessary and when it's not. Such complexity notwithstanding, there are a several basic concepts that go a long way to help understand this disease, and devise a strategy to manage it.

Botrytis cinerea is very widely dispersed, and can overwinter as resting structures on infected canes, or more commonly, in various vineyard debris. Old cluster stems appear to be a particularly common source of inoculum. *Botrytis* is a "weak" pathogen that primarily attacks highly succulent, dead, or injured tissues, or tissues that are senescing.

Photo I: Characteristic fungal sporulation and symptoms of Botrytis bunch rot on a severely affected Chardonnay cluster. Distribution of diseased berries (a continuous mass, with sporulation intensity diminishing toward the edges) suggests significant berry-to-berry spread from one to a few original infection sites near the center of the rotten zone.

Berries damaged by insects, powdery mildew, or splitting, due to pre-harvest expansion and/or rain, are common injury sites attacked by *Botrytis*. Withering blossom parts and ripening fruit are senescing tissues of particular importance to the initiation and development of BBR.

The fungus thrives in high humidity and still air, hence the well-known value of cultural practices such as leaf removal and canopy management to minimize these conditions within the fruit zone.

Photo II: A single diseased berry resulting from infected blossom debris, visible next to the capstem. Berry-to-berry spread from such "point sources" can lead to significant loss, and is particularly favored by tightly-compressed bunches and pre-harvest rains. (Photo courtesy Dr. W.D. Gubler)

Photo III: Cluster development at the time of fruit set is the ideal time for leaf removal. (Photo courtesy Dr. W. D. Gubler)

Although the fungus does not grow well inside berries until they start to ripen, it can gain entrance into young fruit through senescing blossom parts, old flower "trash" sticking to berries within the cluster, and scars left by the fallen caps.

Infection requires that tissues remain wet for at least several continuous hours (rain). The ideal temperature for infection is approximately 60–75°F, although it can occur at temperatures outside this range under longer wetting periods.

Infections early in the season remain confined to a few cells and latent (dormant) while berries are green, but given the "right" conditions, some of them can resume activity, and progress to the point that they rot the affected berries as the grapes approach maturity. Once this occurs, the disease can spread rapidly from berry to berry within clusters and, to a lesser extent, among clusters.

The likelihood and magnitude of disease spread depends on weather conditions and certain physiological factors within the vine.

The following are some recent findings concerning various details of this basic scenario, and the fungicides that are used to control the disease. Although this work was conducted in the Finger Lakes region of New York, the general principles should be applicable to California as well, although certain specifics will obviously be different.

Latent infections can be common following a wet bloom period, but the vast majority of latent infections appear to remain inactive through harvest, meaning that the fruit stays healthy. For example, when we've inoculated Pinot Noir clusters with *Botrytis* spores at bloom, we've been able to detect latent infections in up to

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Table I. Influence of post-veraison soil water status on the activation of latent *Botrytis* infections in clusters of potted Chardonnay grapevines

Soil treatment	Diseased clusters (%) Harvest[z]	Post-incubation[y]
Dry	17.1	42.1
Wet	56.0	61.3
t-test	P = 0.02	P = 0.30

[z] Assessments at harvest

[y] Assessments after 4 days incubation at 68°F/ >92% RH

70% of the young berries that we've sampled at various stages thereafter.

However, we often end up with only 2% or 3% rotten berries at harvest, especially in a dry autumn or a clone with loose clusters. On the other hand, we've ended up with 25% to 40% rot at harvest in clones with tight bunches, particularly in wetter harvest periods; leading to the following point:

Serious *Botrytis* losses result from disease spread during the pre-harvest period, after berries begin to ripen and become highly susceptible to rot by the fungus. Thus, latent infections established at bloom can play a critical role in disease development if even a few infections become active and provide an initial "foot hold" from which spread can occur under favorable pre-harvest conditions.

Sprays to control one, both, or neither of these two phases of disease development may be worthwhile, depending on the specific vineyard characteristics and weather conditions.

The potential importance of early disease establishment, and two vine factors that promote subsequent disease spread, are illustrated by the results of two following field experiments.

In the **first experiment**, we inoculated one, three, or five individual Pinot Noir berries per cluster, 10 days after veraison, by using a hypodermic needle to inject them with *Botrytis* spores. This produced initial "point sources" of the disease within clusters about a week later, which were meant to simulate occasional activations of latent infections before harvest.

To determine the effect of cluster architecture on disease spread from these sources, we utilized clone 29 (very tight bunches) and opened up some of the clusters by removing enough berries after fruit set so that they resembled the Mariafeld clone

Table I: Relative efficacies of some currently-registered fungicides for control of Botrytis bunch rot in Geneva, NY, 1998–2006.

Material, rate/acre	% Control of disease severity, relative to unsprayed check[1] 1998	1999	2000	2002	2003	2004	2005	2006
Check	(11.5)	(7.9)	(12.5)	(8.9)	(16.3)	(48.4)	(9.7)	(31.9)
Vangard 75 WDG, 10 oz	94	85	83	98	---[2]	87	95	93
Elevate 50WG, 1 lb	96		47	93	87	81		87
Flint 50WG, 2 or 3 oz		97[3]	82[3]	96	89[3]		77	85
Pristine 38WG, 8.5 or 10.5 oz				73[4]	49[4]		74	81
Pristine 38WG, 12.5 oz				66	76	75	93	80
Pristine 38WG, 19 oz		100		89	94		96	92

[1] All materials were applied to vines of interspecific hybrid cvs. Aurore (1998–2000) or Vignoles (2002–2006) at bloom, bunch closure, veraison, and two weeks post-veraison. Parenthetical values denote percent cluster area diseased on unsprayed check vines in each year of the trial. All other values within the same column denote percent reduction in diseased cluster area relative to the check treatment that year. Values represent the means from four replicate plots per treatment.

[2] Treatment was not included in this year of the trial.

[3] Flint used at 2 oz/acre in this year. All other entries in row reflect a 3 oz/acre rate.

[4] Pristine used at a rate of 8.5 oz/acre in this year. All other entries in this row reflect a 10.5 oz/acre rate.

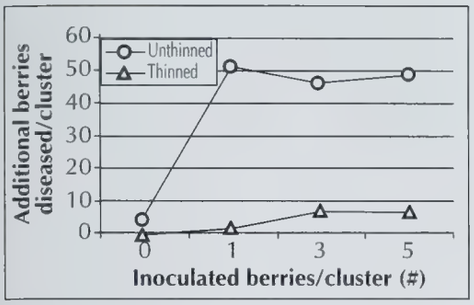

Figure I. Effect of cluster tightness on disease spread. Selected clusters on vines of Pinot Noir clone 29 were hand-thinned after fruit set to approximate the looseness of those of the Mariafeld clone. Either 0, 1, 3, or 5 berries per cluster were inoculated 10 days after veraison and disease was present on those initial "point sources" 1 wk later. Data reflect the number of additional berries to which the disease had spread by harvest.

(loose clusters, generally less prone to bunch rot than other Pinot Noir clones under commercial conditions).

In Figure I, *Botrytis* was able to spread extensively throughout the unthinned clusters. One single rotten berry that appeared 2½ weeks after veraison was all it took to end up with 50 additional rotten berries at harvest (pre-harvest weather was wet that year).

In contrast, disease spread was minimal in the thinned clusters. Additional experiments showed that the relative *Botrytis* resistance long noted for the Mariafeld clone can be accounted for simply by its loose bunches rather than some inherent chemical factor.

In the **second experiment**, clusters of a tight-bunched Chardonnay clone were similarly thinned and inoculated. Additionally, some vines received four weekly sprays of urea (8 lb urea in 100 gal of water per acre), starting at veraison, to see if high berry nitrogen content would affect disease spread.

This treatment increased the mean level of assimilable nitrogen in the must to 303 mg/L, compared to 235 mg/L in the untreated plots (determinations from 10 clusters per each of four replicate plots per treatment; differences between the two treatments were statistically significant at P = 0.05).

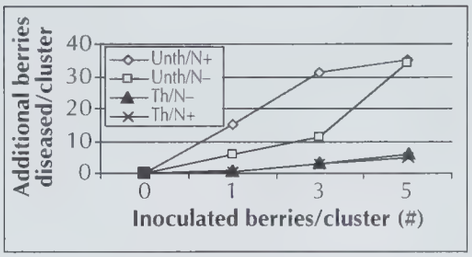

Figure II. Preharvest spread of *Botrytis* on Chardonnay berries as affected by the number of initial infection sites, cluster architecture, and berry nitrogen status. Vines designated as "N+" received four weekly foliar sprays of urea (8 lb/A) starting at veraison. Selected clusters on vines both with and without foliar N were hand-thinned after fruit set (Th) to approximate the looseness of those of the Mariafeld clone of Pinot Noir. Either 0, 1, 3, or 5 berries per cluster were inoculated 10 days after veraison and disease was present on those berries 1 wk later. Data reflect the number of additional berries diseased after harvest.

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Kevin Skene, Skene Viticulture, Santa Rosa, CA manages 1,560 acres of winegrapes in Sonoma County. He has used Stylet-Oil for four years (post-bloom to veraison) to achieve optimal control of powdery mildew and botrytis when tank-mixed with systemic fungicides. He also uses Stylet-Oil to suppress mite populations, and has been able to reduce the need for miticides by up to 70% in vineyards with a mite history. Stylet-Oil may help to suppress mealybug crawlers.

Steve Mudd, Mudd Vineyards, Southold, NY manages more than 450 acres of winegrapes on Long Island, NY. He makes five or six applications per year (starting post-bloom) of Stylet-Oil to control powdery mildew, and also achieves control of red spider mites with a maximum 1.5% per 100 gallons of water application.

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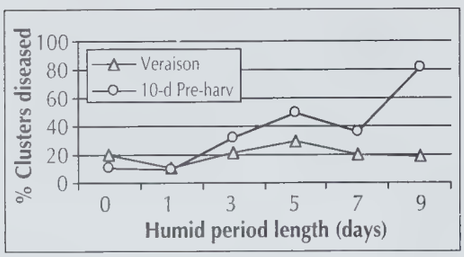


Figure III. Effect of relative humidity and humid period length on the activation of latent *Botrytis* infections. Clusters on potted Chardonnay vines were inoculated with *Botrytis* spores at bloom to establish latent infections in the berries, and protected from rain thereafter. Vines were then moved to a chamber with RH > 92% for 0 to 9 days, beginning at veraison or 10 days before harvest. Data are expressed as the percentage of clusters showing any berries diseased with *Botrytis*.

In Figure II, little disease spread occurred in the thinned clusters, regardless of nitrogen treatment. In contrast, elevated berry N did increase spread in intact clusters with either one or three initial points of infection. The late season nitrogen applications did not increase canopy growth. Therefore, it appears that their effect on disease development was due to an increased susceptibility of berries to fungal colonization as the nitrogen content increased, rather than an increase in canopy density and associated microclimate effects.

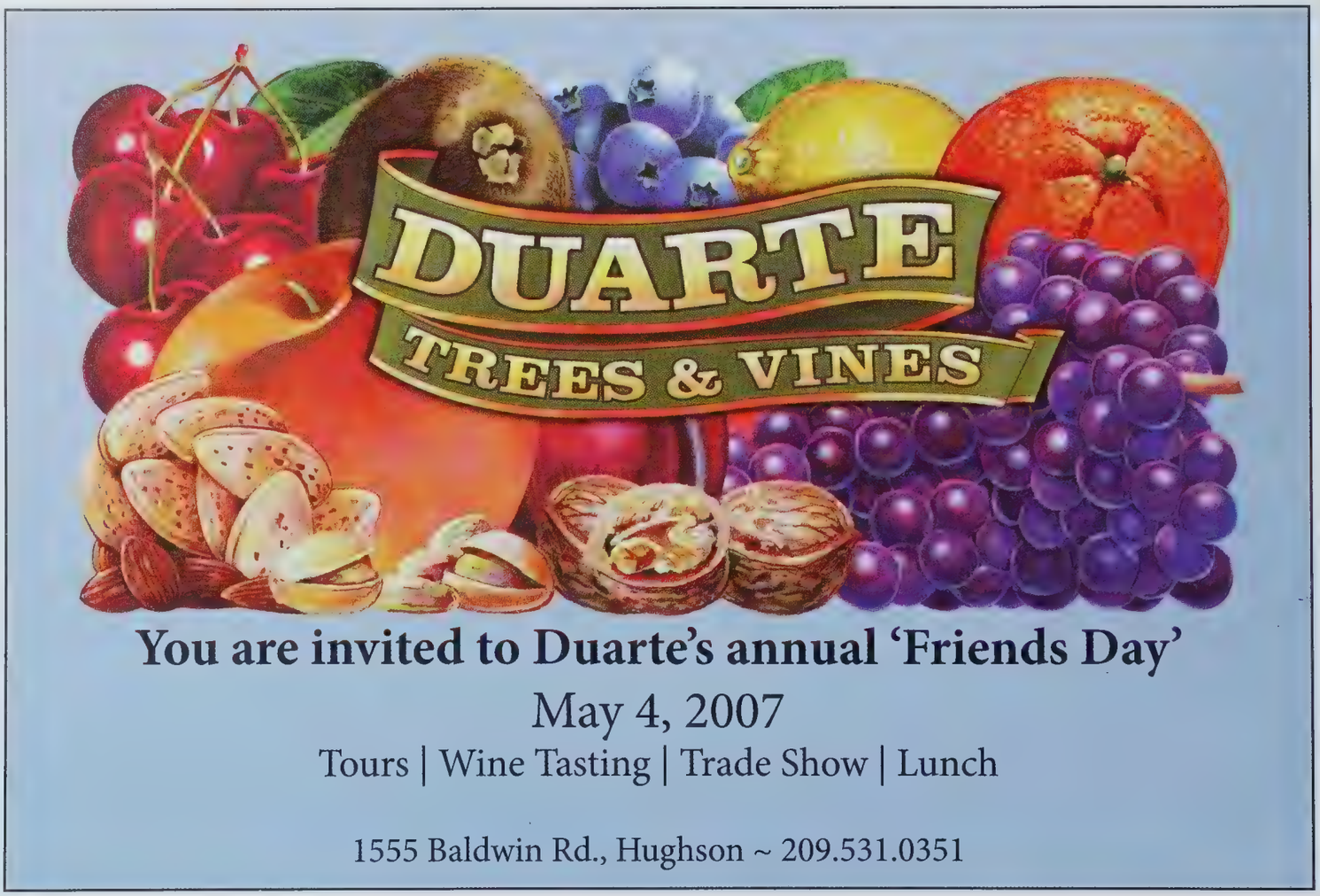
In Figure II, the analysis of variance showed a highly significant ($P<0.001$) interaction between the thinning (opening up) treatment and nitrogen treatment.

Factors that determine whether latent infections become active and cause disease, or remain latent and symptomless, are poorly understood. However, the activation of latent infections appears to be influenced by both the weather and vine physiology. Experience and controlled experiments both show that high atmospheric humidity during a several day period prior to harvest is one such factor that promotes this process.

To examine this factor, we inoculated clusters of potted Chardonnay vines at bloom in order to establish latent infections. The vines were kept outdoors, protected from rain.While all clusters were still symptomless, we moved them into a high humidity (92% RH) chamber for 0 to 9 days either at veraison, or starting 10 days before harvest.

In Figure III, the percentage of clusters with disease symptoms (due to activation of latent infections) increased in proportion to the duration of the high humidity treatment pre-harvest, but was not affected by high humidity at veraison.

In addition to high atmospheric humidity, high soil moisture can also promote activation of latent infections. The influence of this factor is illustrated by the following experiment, in which potted Chardonnay vines were once again inoculated at bloom to establish latent infections and grown in a screenhouse, where they were protected from rain and irrigated as needed to maintain moderate growth and avoid drought stress.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At veraison, the vines were split into two groups: a) watered several times per week to keep the soil moisture levels constantly high (wet); or b) watered only when shoot tips began to wilt (dry). On these occasions, water was provided to alleviate stress, but the soil was not saturated.

Pots receiving the two irrigation regimes were interspersed among each other randomly. Therefore, all clusters were subjected to the same atmospheric environment, and only the soil environment was different.

Disease incidence was determined in two manners: 1) at the time of harvest; and 2) after harvested clusters were incubated for four days at 68°F and 92% RH, to promote additional activation of latent infections. There were seven replicate plants with six clusters per plant for each of the two treatments.

In Table I, disease incidence (the best indicator of latent infection activation), was more than three-fold greater at harvest in the wet compared to dry soil treatment. However, most of this difference was no longer evident after post-harvest incubation, by which time there was no statistical difference between the two treatments.

This "leveling off" between the two treatments was due to the pronounced increase in disease incidence for clusters from the dry, but not the wet, treatment following incubation and represents the activation of multiple latent infections during the post-harvest incubation period.

Thus, it appears that the wet-soil treatment provided conditions that were more conducive to the activation of latent infections than did the dry treatment while clusters were on the vine, but that many latent infections in the dry treatment remained viable and activated upon exposure to high atmospheric humidity during incubation.

As for most fungi, *Botrytis* spores require a film of water in which to germinate and initiate infections. Thus, rainy pre-harvest weather sets off a chain reaction, in which earlier latent infections are activated by high atmospheric humidity and high soil moisture. High humidity promotes spore production by the fungus from debris and newly-diseased berries, and free water on the berry surfaces promotes germination and new infections by these spores.

Control

Cultural practices such as canopy management and leaf removal are widely practiced and effective components of BBR management programs. Dr. Doug Gubler (University of California, Davis, who first demonstrated the value of leaf removal), emphasizes that this operation should be undertaken during the very early stages of berry development, at fruit set, to help avoid sunburn damage. In encouraging California growers to remove leaves early, Gubler recently noted that some, "have been pulling leaves later and later and are running into sunburn problems, [leading to] secondary fungal infections such as Cladosporium."

Removal or destruction of vineyard debris, particularly old cluster stems, is theoretically useful and something to keep in mind insofar as it is practical. However, fungicide sprays targeted specifically at BBR may be necessary on susceptible cultivars and/or clones, particularly in a wet year. The questions are, which materials and when?

Not surprisingly, the optimum timing for spray applications is heavily weather-dependent. This probably accounts for the sometimes contradictory opinions and data regarding the relative importance of sprays at the times when they might potentially be applied, such as bloom, pre-bunch close, veraison, and pre-harvest.

A bloom application is designed to prevent the initial establishment of infections through susceptible blossom parts, or infected blossom debris trapped within the cluster (see Photo II), and can be important on susceptible varieties during wet flowering periods, especially if pre-harvest conditions are wet also.

Veraison and pre-harvest sprays are designed to prevent both initial infections through injured berries and, especially, the spread of active infections through the ripening clusters. These are often the most important spray timings in humid climates with regular summer and autumn rainfalls.

Although most effective when applied ***before*** an epidemic is in progress, such sprays can still help to

slow down the rate of spread if applied relatively soon after the disease first appears and threatens to "take off."

Unfortunately, most fungicides that control other diseases are relatively ineffective against *Botrytis*, either providing no significant control or requiring substantially higher rates than required for other diseases. Similarly, most *Botrytis*-specific fungicides provide no significant control of other disease-causing fungi (including other causes of bunch rot), although there are important exceptions.

Do not forget that all of the *Botrytis* fungicides are at moderate to high risk of resistance development. This makes it very important to rotate among groups of fungicides used to control this disease, even if you make only occasional applications. Don't use the same one year after year without substituting something else along the way. Following is a brief review and some new information regarding the fungicides available for *Botrytis* control.

Before discussing specific materials, let's define a few of the terms that will be used with respect to fungicial activities:

Protectant — Provides control when applied ***before*** the infection process begins.

Post-infection — Provides control when applied for some period of time ***after*** the infection process begins, but before symptoms appear. This period of time is often limited to one to several days, but for some materials can be significantly longer with respect to control of latent infections.

Anti-sporulant — Significantly reduces the production of spores from infected tissues, although other symptoms may appear or persist.

VANGARD, SCALA — These represent two different fungicides in the same class of compounds (the anilinopyrimidine or "AP" fungicides), so "rotating" between them will provide no benefit in terms of resistance management.

These compounds appear to have equivalent properties and provide the same general levels of control at labeled rates, although Scala (not registered for application on grapes in California) has been a bit weaker under high disease pressure in a couple of New York trials. In general, these have been the most consistent performers in our field trials over the years, and provide both protective and post-infection activity. (See Table I.)

In recent tests where we've inoculated Chardonnay or Pinot Noir clusters with *Botrytis* spores at bloom, and then sprayed at veraison (before the latent infections became active), both materials eradicated over 90% of latent infections, even though they had been established almost two months earlier.

(NOTE: The clusters in these experiments were sprayed individually by hand, so coverage was absolutely thorough and superior to what would be expected under commercial conditions.) The resistance risk for the AP fungicides is high, so rotation is very important. These products provide no significant control of any disease other than *Botrytis*.

ELEVATE — The other "work horse" against *Botrytis* over the past decade. Elevate is not related to any other fungicide on the market, so is an excellent rotational partner. In New York field trials, we've seen the same control whether Elevate was rotated with Vangard or either one was used alone. Conventional wisdom has it that this is a protective fungicide, with no post-infection activity.

In contrast, we have several years' worth of data to indicate that Elevate does have some post-infection activity, and that it can suppress or eradicate latent infections if applied before the infections start to become active. Elevate provides no significant control of any disease other than *Botrytis*. Resistance risk is moderate.

PRISTINE — The combination product of a strobilurin (pyraclostrobin), plus a compound representing a new chemistry on grapes (boscsalid). Both components are active against *Botrytis* (boscalid is the more active of the two), which is good from a resistance-management perspective.

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Application rate is important. When used at the rate of 8.5 oz to 10.5 oz per acre it is highly effective against powdery mildew and several other diseases, but control of BBR is only fair under anything more than moderate pressure.

There is no mention of *Botrytis* on the label *at this standard use rate,* so the company makes no claim concerning activity against this disease. However, Pristine is labeled for "suppression" of *Botrytis* at a rate of 12.5 oz per acre, and has provided good to very good results in a limited number of tests that we've conducted using this rate. In New York, I would consider 12.5 oz per acre to be marginal under very rainy conditions post-veraison, although it will certainly be much better than applying nothing and may be adequate under marginal pressure.

Pristine has a supplemental label for "control" of *Botrytis* at 18.5 to 23.5 oz per acre. It has provided very good to excellent control at a rate of 19 oz per acre in several trials that we have run under very rainy conditions. It also has a much broader spectrum of activity against other fungi than do the *Botrytis*-specific materials mentioned above, and it gave very good control of the numerous non-*Botrytis* rots that developed in our plots during a very wet September in 2006.

The re-entry interval (without protective clothing) is 24 hours at rates up to 12.5 oz per acre, but jumps to five days at the higher rates.

Botrytis-specific materials will provide some control of other rot organisms by reducing the amount of damaged fruit susceptible to secondary invasion, but these are not the only infection courts open to such invaders. Therefore, a broad-spectrum material such as Pristine will provide "additional" control of non-Botrytis rots via direct effects on such organisms, which is why this is such a good material for general bunch rot control.

Pristine provides both protective and limited post-infection activity, although the post-infection activity has not been as great as that for the APs or Elevate in our tests. The resistance risk for both the strobilurin and non-strobilurin component of this product is high, so rotation is important, although the mixture of two unrelated compounds should help reduce the resistance risk.

Note that Flint is also a strobilurin fungicide, so Pristine and Flint should not be rotated with each other unless a non-strobilurin fungicide is also included in the rotation.

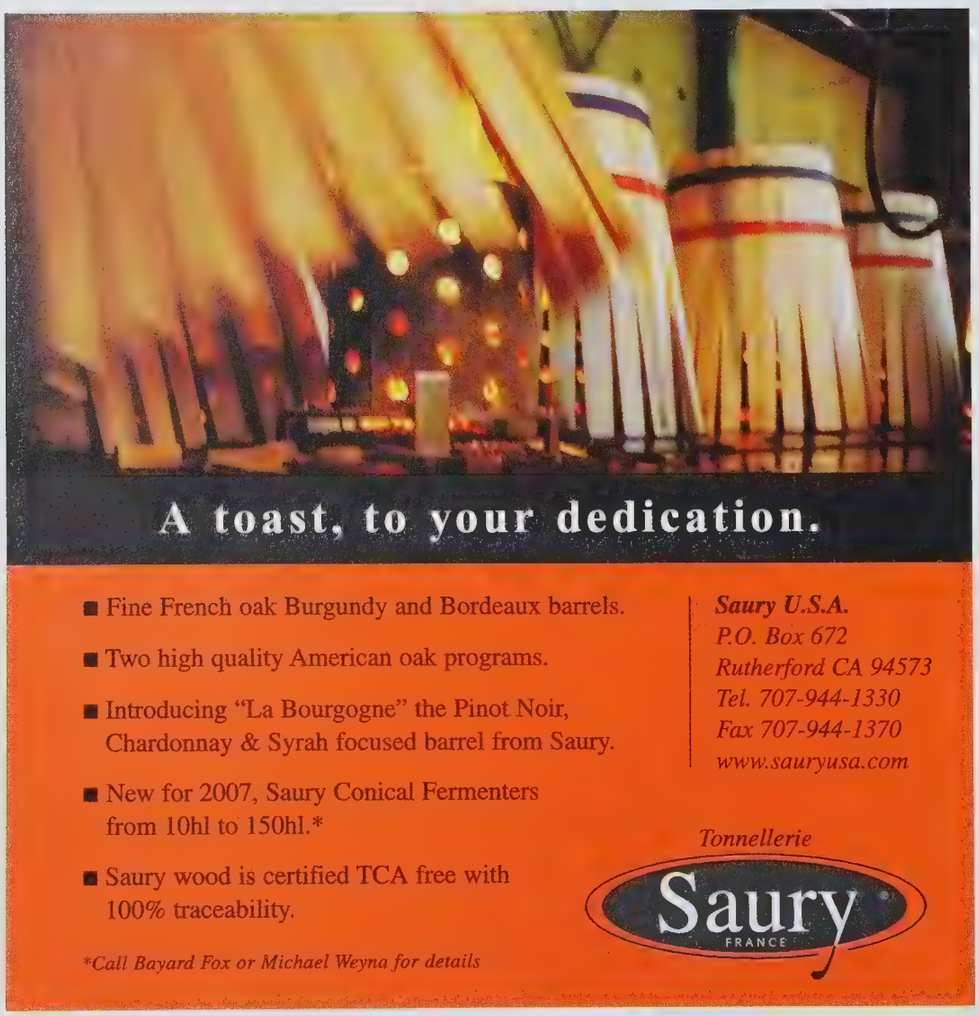
Flint — An excellent powdery mildew fungicide when used at 1.5 to 2.0 oz per acre, it has provided very good to excellent control of *Botrytis* when applied at the 3-oz per acre rate labeled against this disease. It is primarily a protective fungicide. It does suppress spore production from subsequently-diseased tissues when applied post-infection. Resistance risk is high.

Rovral — This was the only true *Botrytis* fungicide available in the U.S. for nearly 20 years, so rotation just wasn't an option. As a consequence, resistance appears to be "not uncommon" in many regions where it was used regularly for many years. However, in locations where use has been much more limited, resistance is much less likely, and the material often performs well. Dr. Gubler reports that resistance to this material has not been a problem in California vineyards.

In the absence of resistance, Rovral is an excellent *Botrytis* fungicide, with both protective and limited post-infection activities. It should be a good rotational partner where resistance is not a major concern, but should be used with caution otherwise. It provides no significant control of any disease other than *Botrytis*.

"Alternative" Products — Although others have, we've never obtained **any** control of *Botrytis* with Stylet Oil or the various potassium bicarbonate products, and I would be very hesitant to rely on them for this purpose under any sort of disease pressure.

Stylet Oil and the bicarbonates both control powdery mildew, which helps to limit *Botrytis* by eliminating one injury site where this fungus might enter, but direct activity against *B. cinerea* is questionable. We have obtained significant control with Serenade, but it has never been as effective as the standard products discussed above. ■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BARREL ALTERNATIVES

Right oak for your wine style

BY Jeff Murrell

Utilizing toasted oak throughout the winemaking process imparts a profound impact on the sensory characteristics of a wine. The following information will help winemakers understand the key variables in choosing oak in their efforts to improve wine quality.

First, a winemaker must determine a wine style before planning the best route to achieve that goal. Before delving into the subtle variables of oak selection, a winemaker must first assess the goals of the winery as a whole. Often, an evaluation of winemaking objectives, coupled with economic and facility parameters, will influence the type of oak to be used for each wine. Such an assessment of goals will lead the winemaker down a path of using barrels, barrel alternatives, or not using oak at all.

Oak barrels are the traditional method of extracting toasted oak into wine. Their ubiquitous presence in winemaking has resulted in some of the finest artisans crafting extraordinary flavor profiles from fire-toasted oak. Aesthetically beautiful, these barrels symbolize the romanticism often associated with winemaking.

The familiarity and satisfaction with the use of barrels in winemaking has propelled them to the forefront of oak integration methods (used to impart oak character into wine). In addition, they act as a container, micro-oxygenator, and concentrator, facilitating the integration of oak during ageing. The desirable qualities of barrels are not without their limitations.

The main disadvantages of barrels are economics and restricted utility. Barrel prices, labor, facility space, ullage, leaking, maintenance, and sanitation all factor into the significant economic cost of using barrels. Furthermore, their fixed container sizes limit winemaking capabilities.

Rapid oak extraction, simple fermentation of red wine on oak, and overall versatility are stifled by the use of barrels. Today, these disadvantages have been overcome by the use of barrel alternatives.

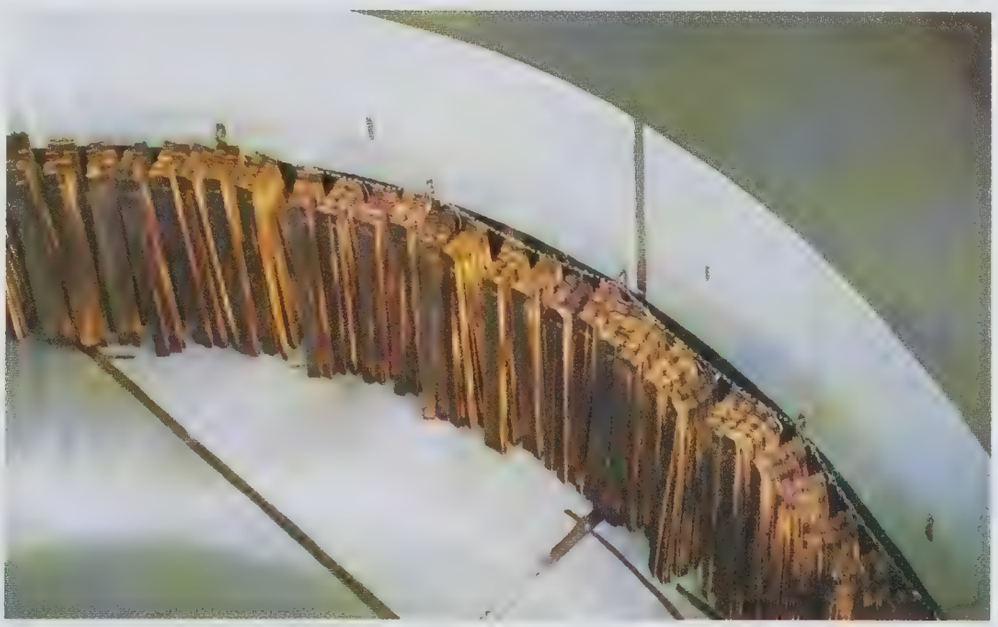
Barrel alternatives provide cost savings and versatility that are helping them become increasingly competitive with barrels. Their main advantage is often perceived as an economic one. Alternatives cost significantly less than barrels while, at the same time they decrease labor expenditures, wine loss, and spoilage potential.

While price was the initial driving force into barrel alternatives, flexibility and quality have elevated their utility to that of barrels. The availability of toasted oak in various sizes and surface areas allows winemakers to manage oak extraction rates and utilize oak for short timeframes, long-term ageing, and during red fermentation.

In addition, the availability of quick-extracting oak products allows winemakers to customize oak blends for individual wines using bench-top trials.

While the plethora of barrel alternative products has provided a wealth of tools for oak integration, it is also a source of much apprehension and confusion.

Disadvantages of using barrel alternatives are primarily due to the relative newness of this oak integra-



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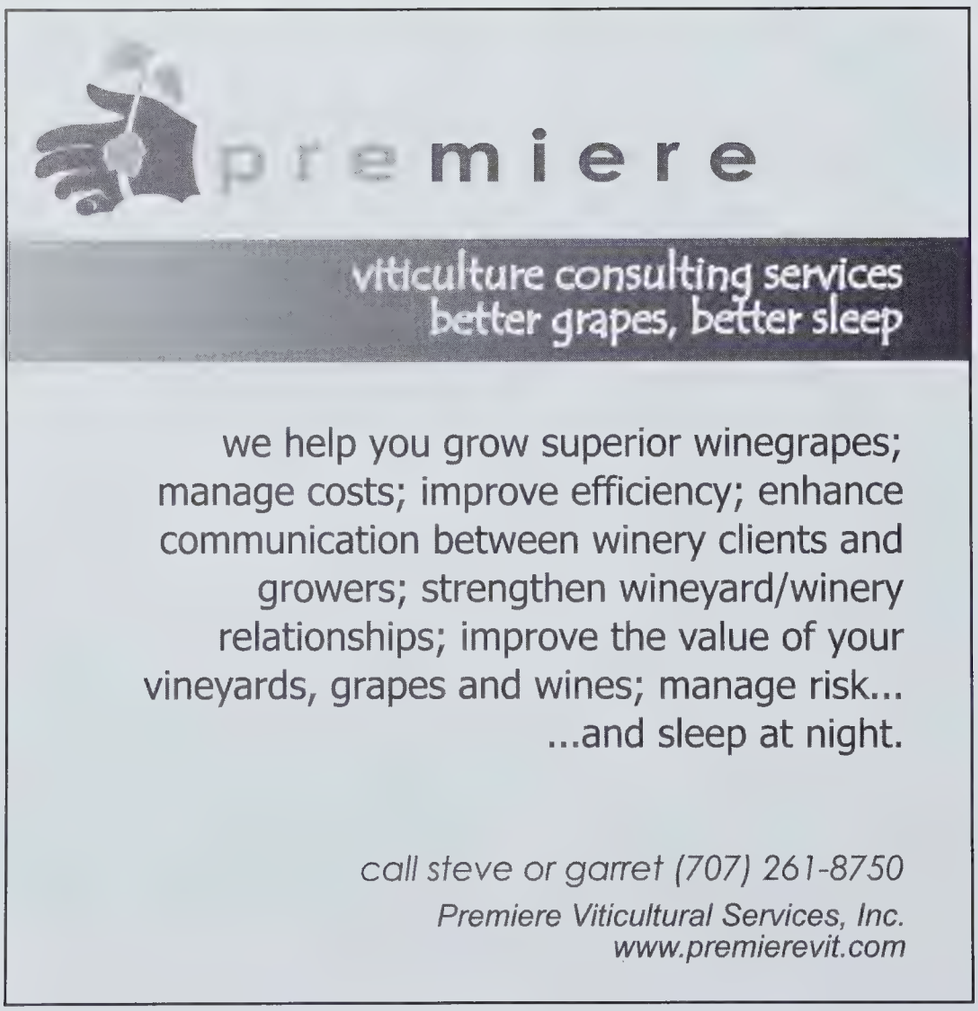
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tion method. In contrast to barrel production, there are very few artisan companies producing high-quality barrel alternatives by hand fire-toasting. In addition, a low barrier of entry into the barrel alternative business has resulted in some low-cost second-rate products that tarnish the reputation of the barrel alternative category.

Another disadvantage related to the newness of this methodology is the learning curve required to take advantage of it. Familiarity with barrels and apprehension concerning barrel alternative product choice, dosage rate, and micro-oxygenation have affected the implementation of this oak-integration method.

Aesthetics and tradition associated with barrels have also been stumbling blocks for the incorporation of barrel alternatives. These qualities are utilized in tasting rooms and marketing campaigns to portray the elegance and romanticism of winemaking.

A final goal for barrel alternatives is the incorporation of evaporative wine concentration.

Wineries feeling that oak extraction has a beneficial effect on their wine quality have achieved their desired results through technology or by rotating wines into barrels during the life of a wine.

Finally, the right choice for oak in your wine may be none at all. Sometimes less is more with certain grape varieties.

Once a winemaker has decided between barrels and alternatives, it is time to shift focus to more nuanced facets of oak selection. Oak origin, species, size, grain tightness, cooperage, seasoning protocol, toasting procedure, and oak concentration have all been touted as important facets of oak selection.

In my experience, resultant wine quality is more important than any of these factors. A consistent oak toasting facility coupled with a sensory evaluation of each individual wine is the

definitive method for choosing the right oak for a wine.

A good relationship with a quality supplier is the first crucial variable in choosing the best oak for a wine. The supplier must have a reputation for high quality, consistency, integrity, and great customer service. Developing a relationship is key to determining the best oak treatment for each individual wine.

The second crucial variable in oak selection is sensory evaluation. In attempting to find the optimal oak for a wine, toast level, seasoning method, oak origin/species, grain tightness, and oak concentration should be evaluated. The evaluation will be determined by the winemaker's palate and should be based upon the ability of the oak to deliver the desired textures, flavors, and aromas coupled with the wine's capacity to integrate synergistic levels of oak. Each of these factors is highly subjective.

Factors that a winemaker finds important will allow each wine to be stylized to a unique vision. Desirable oak parameters are commonly determined by experimentation and strengthened through years of refinement and familiarity.

Truth be told, there is no one right oak for every wine. The best a winemaker can do is experiment and evolve the oak regimen in order to get closer to the ideal wine. ■

Jeff Murrell earned a Ph.D in Bioorganic Chemistry from UC Davis. His experience with toasted oak has developed from years of winemaking and currently as the director of research at StaVin, Inc.

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Factors affecting the influence of oak chips on wine flavor

BY J. I. Campbell, A. P. Pollnitz, M. A. Sefton, M. J. Herderich, I. S. Pretorius,
Australian Wine Research Institute
Adelaide, SA Australia

Demand for the flavor associated with oak maturation of wine has resulted in the continuation of oak barrel use, despite the inherent costs, associated labor requirements, and availability of stainless steel tanks to modern winemakers.

Although maturation in oak casks remains the preferred form of oak usage with higher quality wine, cost-effective alternatives are available. Alternatives include: oak chips, shavings, and larger pieces of oak.[7,11] Off-cuts are commonly used, as they are of unsuitable dimensions for stave production in barrel manufacture.[15]

The impact of oak on wine flavor is derived primarily from extraction of volatile aroma and flavor compounds from oak into wine. Some of these important compounds and their aroma thresholds and descriptors are listed in Table I. We have published a table of similar data for 17 target oak compounds in the *Australian Journal of Grape & Wine Research*.[19]

Some oak-derived compounds, such as the *cis*-isomer of the oak lactones, are present in significant quantities in untreated oak, but others (such as vanillin, guaiacol, 4-methylguaiacol, and furfural) are formed mainly from oakwood polymers that are broken down by heat (during coopering), hydrolysis (by wine acids), or a combination of both.[6,10,12] Therefore, alternative oak products are often heated in order to mimic the sensory effect of oak barrel usage.

Apart from the origin and composition of raw oak products, many factors have the potential to determine the sensory outcome of using oak chips or oak barrels in winemaking. For oak fragments, these include chip size, chip heating time and temperature, timing of oak addition and contact time with wine, pre-treatment of chips with sulphur dioxide, and shelf life of chips.

Size of oak chips

Numerous investigations, including a major study by the Australian Wine Research Institute have shown that the evolution of oak-derived flavor compounds in barrel-aged wines continues over a prolonged period, sometimes over several years.[16,17,18] This is probably due, in part, to the time taken for wine to penetrate the oak staves and for flavor compounds to permeate back into the wine, but could also be due to a continual formation of these compounds in the wood matrix during maturation.

With smaller oak pieces, we might expect extraction to take place much faster due to the large surface area, especially with fine shavings, and this expectation can be confirmed by experimental evidence. Thus, a comparison of extraction of *cis*-oak lactone into wine from larger oak fragments (aver-

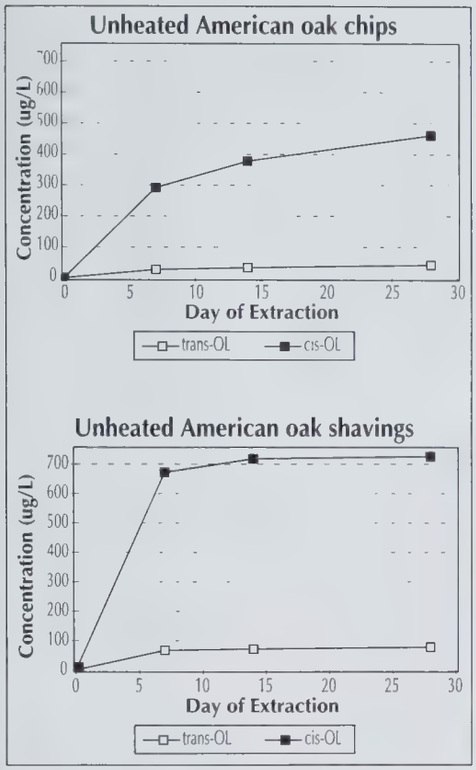

Figure I: Evolution of oak lactone (OL) in model wine extracts of unheated American oak chips and smaller shavings.

age size of 15 x 15 x 5 mm) with that extracted from the same quantity but smaller fragments (10 x 2 x 2 mm) from the same sample of wood (Figure I) shows that a greater amount of this compound was extracted from the finer fragments over a 30-day period.

Extraction from the finer shavings was rapid during the first seven days, after which there was little increase in *cis*-oak lactone concentration in the wine. A similar trend was seen for this and other analytes in other oak samples previously analyzed.

Although the evolution of volatile compounds from fine shavings into model wine was complete or near-complete after only a few days, the oak shavings were not entirely depleted of extractable material. When fine shavings were added at a dose of 10 g/L, and repeatedly extracted with four successive volumes of fresh model wine, around 90% to 98% of the total extractable guaiacol and 4-methylguaiacol, but only 70% to 85% of the oak lactone isomers, was recovered in the first soaking. Most of the remainder was extracted into the second soak.

At a dosage of 100 g/L, extraction efficiency was even less, with only 45% to 60% of the total extractable analytes found in the first soak, and significant amounts (10% to 15% of the total extracted over the four successive soakings) were recovered in the final soak. Thus, preparing concentrated extracts of oak shavings in wine and then diluting these ten-fold with untreated wine will not have the same sensory effect as simply adding shavings to the total wine volume at one-tenth of the dosage.

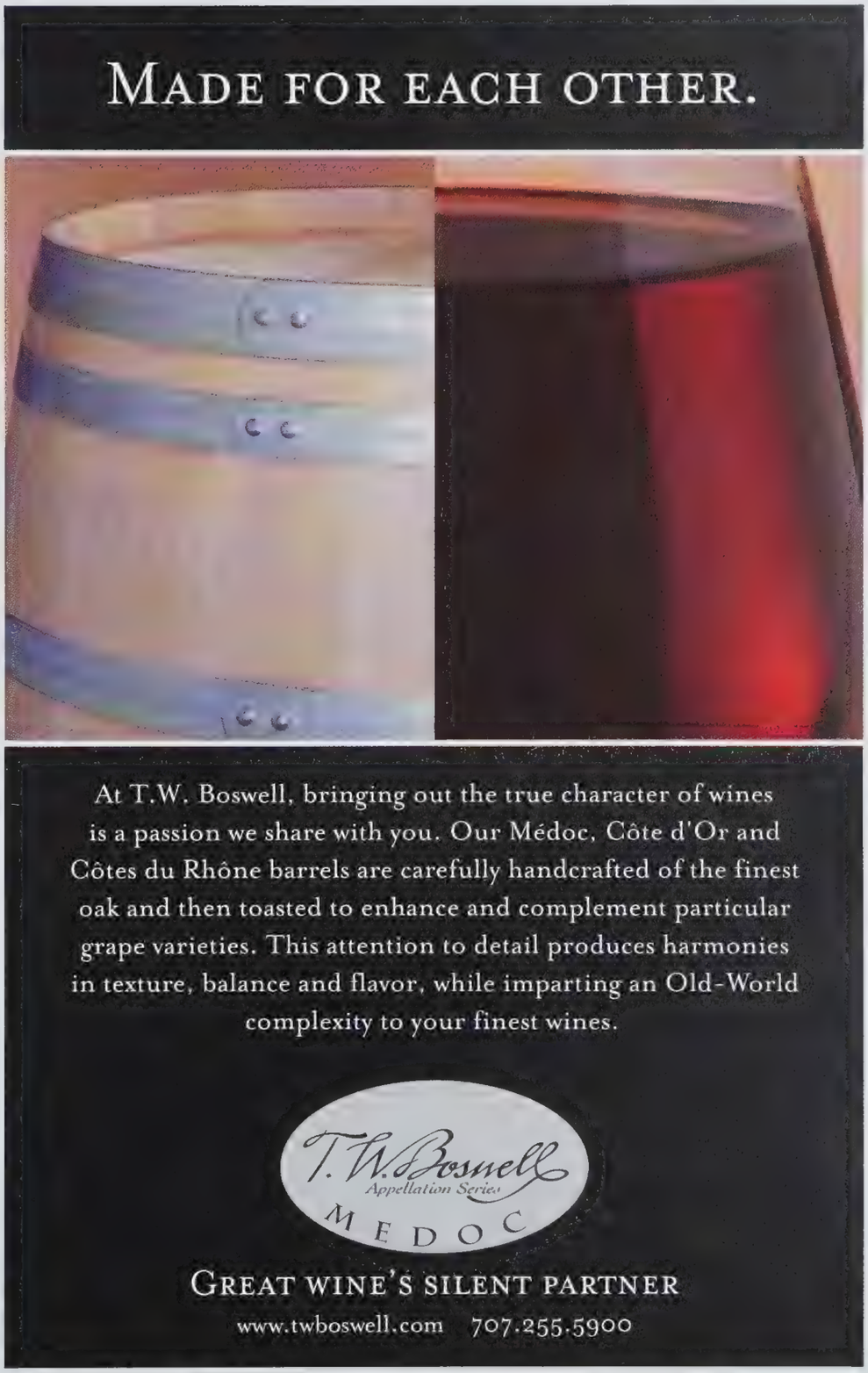
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Table I. Some important volatile aroma compounds derived from oak and their aroma thresholds and descriptors.

Compound	Aroma descriptors	Threshold (µg/L)	Medium	Reference
guaiacol	smoky	20	white wine	1
4-methylguaiacol	smoky	65	red and white wines	2
cis-oak lactone	coconut, oak, vanilla,	20	white wine	3, 4, 5
(natural isomer)	fruity, woody, caramel	54	red wine	3, 4, 5
trans-oak lactone	coconut, oak, weedy,	140	white wine	3, 4, 6
(natural isomer)	woody, hay, jasmine	370	red wine	3, 4, 6
vanillin	vanilla, vanillin	400	white wine	2
		320	red wine	2

Table compiled from the following references: Simpson et al. 1986 (1), Boidron et al. 1988 (2), Brown et al. 2006 (3), Spillman et al. 2004b (4), Wilkinson et al. 2004b (5), Günther and Mosandl 1986 (6).

Chip size does not just affect the rate and extent of extraction of oak volatiles into wine. Apart from purely practical considerations such as the greater combustibility of finer shavings, the greater surface area to volume ratio of shavings compared to larger oak pieces has a significant effect on the outcome of heating oak pieces, probably because of the importance of air contact to this process.[5]

For oven-heated samples, finer shavings gave a greater yield of volatile phenols. This was particularly the case with vanillin (Figure II).[5]

Another study, conducted under different conditions, indicated that, for chips greater than 5 mm in diameter, the concentrations of vanillin was also approximately inversely proportional to the particle size.[8] However, for oak particles ranging in size from less than 0.1 mm up to 5 mm in diameter, the opposite effect was observed. It is possible that the very small particles gave a greater evaporative loss of these volatiles in their study.

Post-extractive formation of oak-derived volatiles

Vern Singleton and D.E. Draper reported that oak aroma in wine treated with oak chips appeared to increase over time after oak chips were removed.[14] Such an observation could be due to one or both of two factors:

First, the increase in oak aroma could have been stemming from a sensory "unmasking" effect, that is, the

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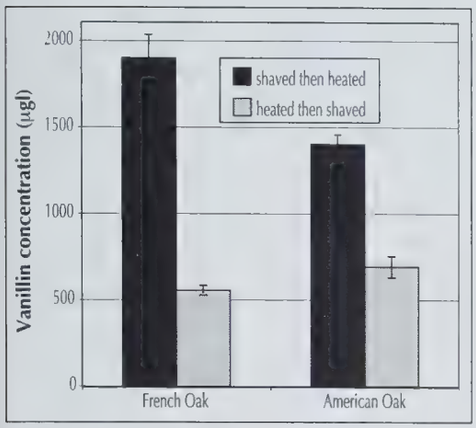


Figure II: Concentration of vanillin in model wine extracts of French and American oak wood chips (10 g/L) of different size heated to 235°C in air (Campbell et al. 2005).

aroma of a given concentration of oak components becomes more apparent with time as other aromas (fermentation or grape-derived) are muted by the ageing process.

The second possibility is the concentration of oak compounds in wine might continue to increase during wine maturation as a result of chemical formation from soluble precursors. This latter possibility has been suggested by several observations.

First, although both guaiacol and 4-methylguaiacol are considered to be primarily products of toasting and are significant components of wood smoke, these two compounds show quite different profiles of extraction from oak barrels over a two-year period.[17]

Guaiacol was extracted most rapidly in the first six weeks, but then continued to accumulate in a near-linear fashion for the remainder of the barrel storage period, whereas 4-methylguaiacol did not increase significantly in concentration beyond the first year of storage.

The accumulation curve for vanillin was asymptotic during the first 32 weeks and linear thereafter, indicating more than one mechanism for forming this compound in oak extracts.

The accumulation curve for cyclotene was linear throughout the entire maturation period. This is consistent with this compound being generated by slow acid hydrolysis of precursors formed during coopering.[17] Although cyclotene itself is unlikely to have any major impact on wine aroma, this behavior illustrates the importance of processes other than simple extraction in determining the composition of barrel-aged wines.

None of these observations, however, demonstrate whether the precursors to these compounds were extracted into solution and then hydrolyzed or remained bound to the wood and were hydrolyzed within this matrix.

More recently, we showed that the time necessary for the ring-opened (odorless) precursor of *cis*-oak lactone to close completely to the lactone (odor-active) could be of the order of several weeks, depending on wine pH.[21] Therefore, the aroma of any *cis*-oak lactone that might have been extracted from oak shavings as the ring-opened precursor would not necessarily reach full intensity until sometime after such shavings were removed from the wine and the lactonization was completed.

In order to explore the possible importance of hydrolytic processes to the continued formation of oak-derived volatiles after the removal of oak shavings from wine, model wine extracts of both heated and unheated shavings of three oak samples, one French (Troncais, *Quercus sessilis*), and two American (*Q. alba*) were prepared. The shavings were then removed from the wine and the solutions stored at 50°C for 80 days, under air or with inert gas protection.[4]

The evolution of guaiacol in model wine extracts after the oak had been removed was constant over the whole period, and a significant proportion (up to 25% of the total) was formed after the shavings were removed from the model wine.

Smaller increases in 4-methylguaiacol were also observed, with maximum concentrations being reached after 10 to 20 days following removal of the shavings. There was a significant (25% of the total) evolution of *cis* and *trans*-oak lactone in the first 10 days following removal of the shavings, only for a medium-grain American oak sample. This was the only

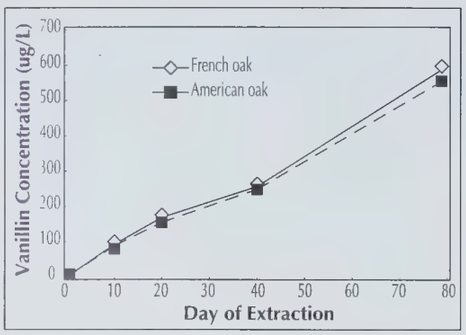


Figure III: Evolution of vanillin in model wine soakings of heated, then pre-extracted oak shavings. Soakings were stored at 50°C for 80 days.

sample of the three that contained significant amounts of extractable oak lactone.

Vanillin showed the largest increase in concentration following removal of the shavings. The percentage of vanillin generated in model wine filtered oak extracts stored under inert gas cover after 40 days at 50°C varied considerably between the experiments (from 10% to 50% of the final vanillin concentration). The generation of vanillin was also enhanced by the presence of air in all of the extracts.[5] This effect of air was smaller for other analytes and not observed for all oak samples.

These results demonstrate that soluble precursors are capable of forming additional amounts of oak-derived volatiles in wine once alternative oak products are removed.

Samples of pre-extracted oak shavings were resuspended in fresh model wine and the mixture heated for 80 days at 50°C. The amount of vanillin in the suspensions was, at first, low. However, the additional vanillin generated over time was substantial (see Figure III), and approximately three times that generated from extractable precursors following removal of the shavings.

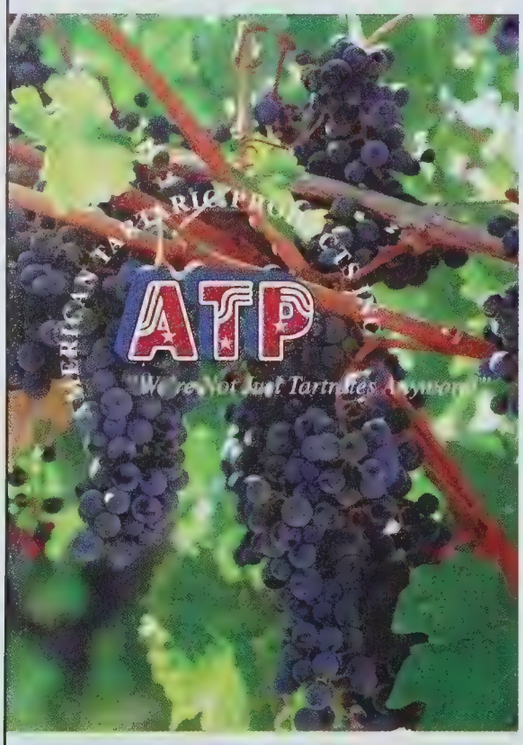
None of the other analytes (guaiacol, 4-methylguaiacol, and oak lactone isomers) were formed in significant quantity in suspensions of the pre-extracted shavings.

From the limited number of samples studied so far, vanillin appears to be formed in sensorially significant quantities by mechanisms other than pure extraction, but this takes place primarily during the time period in which the wine typically remains in contact with the wood. Smaller amounts of guaiacol and *cis*-oak lactone could also be formed from soluble precursors for some samples.

A larger study of many different oak samples needs to be conducted before we can determine whether additional oak aroma can be generated (following removal of shavings from the wine) in amounts that are significant in comparison to the normal variation in oak composition that results from different toasting levels or raw oak composition.

Effect of pre-treating oak shavings with sulfur dioxide

Sulfur dioxide (SO_2) is widely used in wineries as an antimicrobial and



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antioxidation agent. Barrels are often soaked with an aqueous solution of SO_2 (approx. 4 g/hL water of sulfur) prior to use, and after each use. An alternative barrel sanitizing method, sometimes employed by cooperages, is to gas barrels with SO_2 prior to shipment.[1]

There has been little work completed that specifically examines the effects of SO_2 on oak-derived volatiles in wine. J. P. Towey and A. L. Waterhouse briefly address this variable, having observed that increased levels of oak lactones in second-use barrels result from barrel soaking in aqueous solutions containing SO_2.[20] They suggested that SO_2 might aid in dehydration of a postulated open-chain hydroxy acid precursor that results in the lactone form, but this speculation has been refuted.[21]

In a report on barrel maintenance, the effect of SO_2 soaking barrels prior to use appeared to increase levels of both *cis*- and *trans*-oak lactone.[1]

In our trial, unheated and "medium" heated (200°C for one hour) samples of French and American oak, contained in Schott bottles, were exposed to excess SO_2 gas to fill the Schott bottles, which were then sealed and kept for one hour at room temperature. Following this period, SO_2 treated and untreated samples were soaked in model wine under anaerobic conditions.

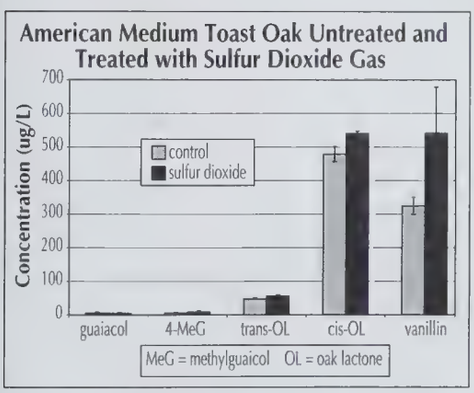

Figure IV: Concentrations of oak volatiles in model wine extracts of heated American oak shavings with or without pre-treatment with gaseous sulfur dioxide.

The largest effects were observed for vanillin. In all the oak wood types investigated (unheated and heated), of both French and American origin, vanillin was extracted to a larger extent (15% to 65% more) in the oak samples that had been treated with SO_2 (Figure IV) when compared to control samples that had been exposed to air instead of SO_2.

A possible mechanism for increased vanillin extraction from oak treated with SO_2 might be through the antioxidative action of this compound that limits inhibiting vanillin degradation.

The heated American oak also showed the largest effects for other compounds (Figure IV). For example, a small, but significantly higher production of *cis*-oak lactone with SO_2 treatment. However, in the other wood samples, *cis*-oak lactone was always in

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greater concentrations in the wood not treated with SO_2, although none of these latter results were statistically significant.

Thus, pre-treatment of oak with SO_2 can result in increased extraction of *cis*-oak lactone and vanillin for some types of oak.

"Shelf-life" of oak chip samples

Oak chips are often left in plastic bags and other containers, for significant periods of time, before use in winemaking. An experiment was conducted to determine the effect of prolonged storage on the concentration of extractable oak-derived volatile compounds.

For the experiment, model wine extracts of commercial French oak chips which had been toasted over an oak-fueled fire (of the same oak) for increasing times, for "light," "medium," and "heavy" toast, were analyzed, along with a commercial sample of American oak chips which were oven-heated in the AWRI laboratory at 175°C for one hour or at 200°C for three hours.

The first analysis of the extracts of oak chips were completed immediately after purchase of new chips, to best represent the initial sampling time, prior to storage. After six months, the chips were sampled a second time and extracted with model wine.

At each sampling date, two dosage levels were used, and duplicate preparations were completed. Between the two sampling dates there was no significant difference in the concentration of guaiacol, 4-methylguaiacol, *cis*- and *trans*-oak lactone, or vanillin after 28 days extraction. Thus, storage of these chips did not affect the level of extractable oak-derived volatiles measured.

Conclusions

Several experiments to determine the importance of some of the variables that could influence the impact of oak chip use on wine composition are described here. These studies are by no means exhaustive, and do not include experiments with larger, plank-sized oak pieces such as oak staves.

We have also not investigated the effect of the timing of oak addition, although there is much evidence in the literature to indicate that most of the vanillin that is rapidly extracted will be converted to relatively odorless derivatives up to the end of primary fermentation.

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It is not easy to predict, in more than a very general way, the outcome of using a particular batch of chips or shavings during winemaking because of the large number of variables that can determine the composition of oak pieces.

One option is to treat a small volume of finished wine with various oak products (or blends of these products) and assess the results sensorially, but this is of limited use if the intent is to add the oak at the start of fermentation.

An alternative is to determine the composition of oak extracts analytically. To make use of such data will require an understanding of the relationship between wine composition and sensory properties which can only be gained from experience and further research. ■

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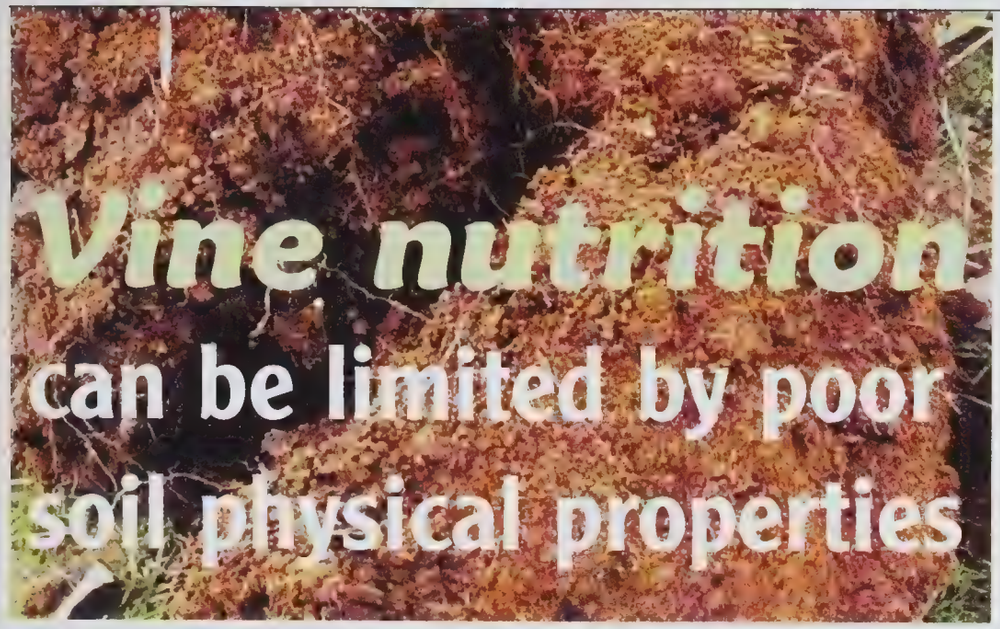

Vine nutrition can be limited by poor soil physical properties

BY Alfred Cass

Nutrient and water uptake by vines are key processes for vegetative growth and fruit production. These processes are critically dependent on a healthy and actively growing vine root system. In turn, root function and growth depend on soil conditions, particularly soil water hydrology, soil strength (resistance to root penetration), and root zone aeration.

Soil water hydrology covers the processes of water entry into, storage, through-flow, and drainage out of soil. Soil strength is the resistance offered by soil to deformation forces, in particular, penetration of plant roots. Root aeration is the availability of oxygen to satisfy root respiration needs.

Soil structure affects the amount, availability, and dynamics of water storage, the dynamics of root penetrability, and the flux of oxygen into and through soil. Roots that are constrained by lack of water, high soil strength, or waterlogged conditions can suffer nutrient deficiencies even though fertilizers have been applied. Consequently, in the absence of optimum soil structure, vines and vineyard sustainability can suffer with decreases in growth, yield potential, fruit quality, and pest and disease resistance, because of inconspicuous impairment of nutrient and water economy.

In this article, the parameters of soil structure are devined in relation to root function and linked to vine nutrient economy. Simple schematic physical models of good and poor soil structure (Figures I to V) show how vine roots function in relation to soil physical structural factors. Other factors, such as soil temperature, presence of toxic chemical elements, and the presence of pests and diseases may also affect root function, but these issues lie beyond the scope of this article.

Mechanics of root functionality

Grapevines, like all crop plants, depend on available soil moisture to satisfy transpirational demand for water. Generally, significant water uptake by plants can only occur between field capacity and wilting point soil water contents.

Water retention values for the field capacity and wilting point soil water contents are usually taken to be 10 and 1,500 kPa of matric suction, respectively. Intersection of these values with idealized water retention curve gives the range of available water (Figure I).

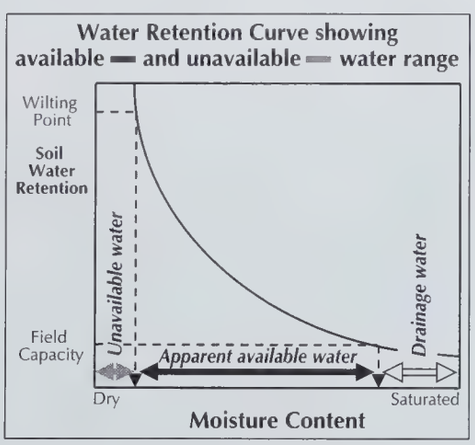

Figure I: Hypothetical soil water retention and soil water content relationship (curve) which allows definition of plant water availability limits: field capacity and wilting point and unavailable (left), available (middle) and drainage (right) water in soil.

Friable, porous soil. (Figure IV-b)

Matric suction is the "suction pressure" by which water is absorbed to soil particles, which works against the suction pressure exerted by plant transpiration in taking up soil water. When the soil has drained but is still moist, the matric suction is low (about 10 kPa) but as soil dries it increases, ultimately reaching a value (1500 kPa) generally accepted as beyond the ability of plants to extract water from soil pores.

The shape of the curve in Figure I is dependent upon soil texture and structure and the shape will determine the range of available water. Outside this range, any water in the soil is either unavailable (on the dryer side of permanent wilting point) or is draining through the soil so fast that plants have only limited opportunity to take it up (on the wet side of field capacity). Alternatively, if the soil is draining slowly (poorly-drained soils), uptake of this fraction of the water will be limited by insufficient oxygen for root respiration (see later discussion on poorly drained soils).

This simple model of soil water retention is generally accepted as the

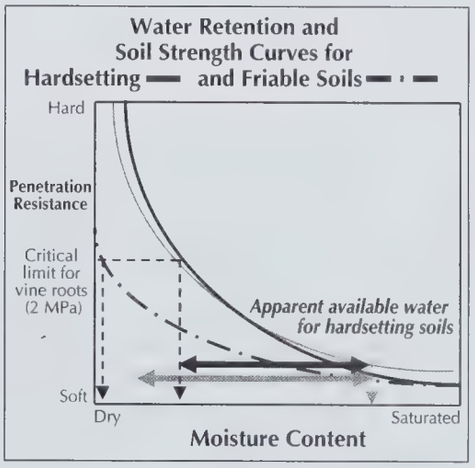

Figure II: Hypothetical penetration resistance relationships and critical limit (2 MPa) for two soil structural conditions, a friable soil (broken black curve) and a hardsetting (solid black curve) superimposed on the soil water retention curve of Figure I. The shortened black arrow represents reduction in available water caused by hardsetting compared to available water in friable soil (grey arrows).

basic mechanism that drives water uptake by plants. However, scientific research has shown that in poorly-structured soils, other factors can limit water uptake, in particular, high soil strength or lack of oxygen in the root zone (poor drainage).

Under these conditions, not only can water uptake be restricted, but root respiration and root growth can be restricted also. These restrictions represent serious limitations to root function and can explain severe nutrient deficiencies that are commonly seen in vines grown on soils rich in sodium or magnesium. In excess, these ions degrade soil structure and thereby restrict movement of water and oxygen.

Soil strength can limit the vine root's ability to grow into untapped sources of water in soil by interfering with root function. As soils dry, the root's ability to penetrate decreases (see Figure II). This model illustrates the penetrability of two very different soils. One is a soft, friable soil showing a slow decrease in root penetration. The other is a strong, hardsetting soil (a steep penetration resistance curve, see Figure II) showing rapid decrease in root penetration as it dries.

It is clear that friable soils only become really hard when they are quite dry while hardsetting soils become significantly hard while they are still relatively moist.

Figure II illustrates that, for friable soils, the intersection of the limit of vine root penetrability (2 MPa or 291 psi) with the penetration resistance (soil strength) curve lies below the permanent wilting point water content and, therefore, does not limit root activity in relation to water availability.

However, a hardsetting soil may have the intersection point above the permanent wilting point water content (Figure II). In this case, soil strength will limit root activity before the permanent wilting point water content is reached.

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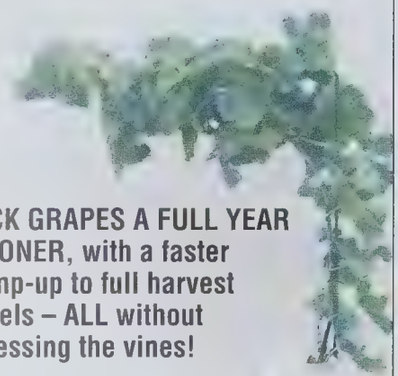

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Rather than the range of available water and root functionality being limited by the permanent wilting point water content, they are limited by the critical soil strength of 2 MPa (291 psi), thus reducing the apparent available water range.

A similar model can be applied to well-drained and poorly-drained soils (Figure III). After rain or irrigation, much of the root zone may be close to saturation. If the soil has many large pores that drain quickly (allowing air to replace water), then there is seldom an issue of restricted oxygen limiting root respiration. However, if the soil structure is dominated by small pores (compact soil) that do not allow sufficient influx of air, then root function may be limited by lack of aeration.

If the soil has less than 10% of its porosity filled with air at water content below field capacity, then a lack of root respiration capacity will limit water uptake and root function until the critical air-filled porosity has been reached by more drainage of water from the pores (Figure III).

The upper limit for water availability is no longer field capacity but the point where soil air-filled porosity allows roots to function properly. In the model for poorly-drained soils (Figure III), this water content lies below field capacity, further restricting the apparent available water range.

Well-structured soils are friable and porous (they have large pores that drain rapidly), and conform to the root function model in Figure IVa. This is also illustrated in Figure IVb, where neither aeration nor strength development are limiting to root activity. Nutrient uptake problems, driven by soil structural conditions, are unlikely in these soils.

On the other hand, poorly-structured soils tend to have both poor drainage rates (dominance of small pores that do not drain rapidly) and high strength development (critically hard even when quite moist). These

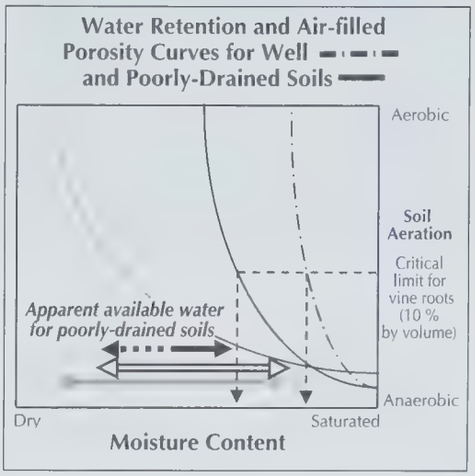

Figure III: Hypothetical aeration relationships and critical limit (10% air-filled porosity) for well-drained (black broken curve) and poorly-drained (black solid curve) soils superimposed on the soil water retention curve of Figure I. Short black arrow represents reduction in available water caused by lack of aeration compared to available water in friable soil (grey arrows).

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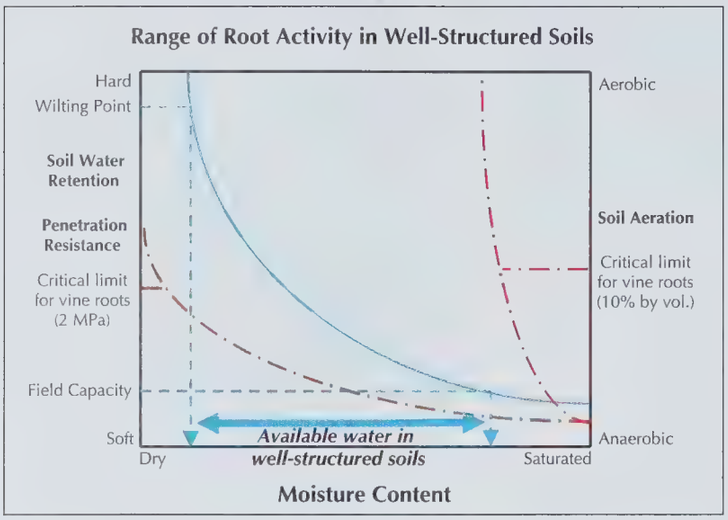

Figure IV-a: oil structural model for a friable, porous, and soft soil with no limitations to root functionality over the available water content range between field capacity and wilting point.

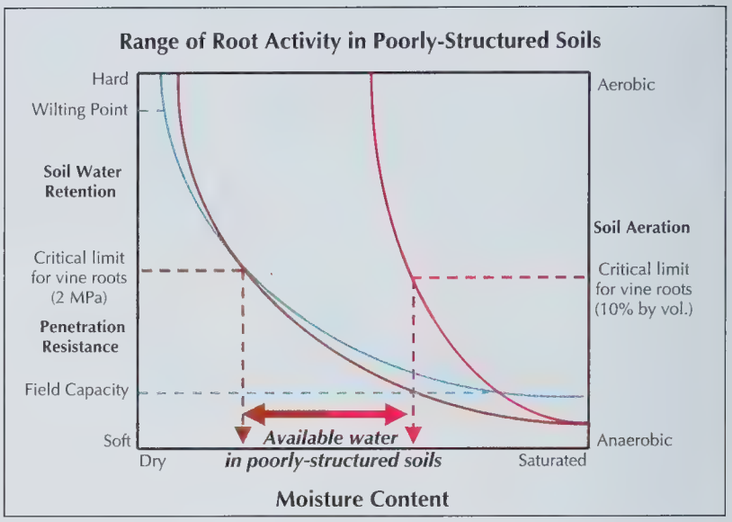

Figure V-a: Soil structural model for a compact, hardsetting soil with significant limitations to root functionality over the available water content range between field capacity and wilting point.

types of soils behave as the model in Figures Va and Vb shows. In this case, restricted root function will dominate the wetting and drying cycles imposed by irrigation. Because of this limit to the range of root activity and growth, nutrient uptake problems are likely to be prevalent in these soils.

Mechanics of nutrient uptake

Most nutrients are taken up from the soil by roots and this process depends upon healthy root function and active root growth. Nutrients must either move through the soil (in the soil solution) towards roots or the roots must grow towards the sources of nutrients. The three important physical mechanisms of nutrient uptake are 1) diffusion, 2) mass flow or convection, and 3) root interception.

Nutrients can move by diffusion, through the soil solution, along a nutrient concentration gradient from regions of high nutrient concentrations to regions of lesser concentration. Where uptake of nutrients is occurring, nutrient concentrations close to the root are lower than further away and nutrients will diffuse towards the root surface. However, diffusion is slow.

For example, a potassium ion (K^+) can diffuse a distance of about 1 mm per day in moist soil, but a phosphorous ion (H_2PO_4!) can diffuse only about 0.1 mm per day. Under drier conditions, rates can drop as low as 25% of these values or less. The data are supported by documented evidence that potassium and phosphorous deficiency may be particularly prevalent in vines if the soil is dry (as in situations where irrigation is reduced or when unirrigated or in very dry years). [Matthews and Anderson 2002, Marschner 1997 p. 494]

For adequate nutrient balance, most plants, including vines, need to obtain as much as 80% of their potassium and 92% of their phosphorus by diffusion. Because of the short-range nature of diffusion, roots have to be in close proximity (about only one millimeter) to the nutrient source. This implies that, for diffusion to be effective, roots need to position themselves by growing towards fresh nutrient sources.

Mass flow of the soil solution into the root system by water uptake can carry nutrients into the plant. Mass flow is faster than diffusion and has a larger spatial range (several millimeters). Plants obtain most of those nutrients that are at higher concentrations in the soil solution (sulfur, calcium, sodium, magnesium, and often boron) by mass flow. Nutrients which are generally at lower concentrations in the soil solution (potassium, phosphorus, nitrogen, copper, iron, manganese, and zinc) cannot be adequately supplied by mass flow only.

Uptake of nutrients by diffusion and mass flow is highest when the soil is at field capacity, and decreases as soil water content decreases. In very hot

Figure V-b: Image of a soil with degraded structure showing dense, compact, impenetrable structure.

weather, particularly as the soil water content drops to low values, transpirational demand may exceed the flux of water towards roots, causing extreme drying around the roots, thus cutting off continuous water flow paths in contact with roots. This will stop both convection and diffusion. This scenario is more likely in poorly-structured soils with low hydraulic conductivity than in well-structured soil with higher hydraulic conductivity (the rate at which water flows through soil).

Roots seek to explore soil so they may physically contact available nutrients that can then be taken up.

Most soil scientists assert that very little of a plant's nutrient requirements are met by root interception. However, given the low ratio of root to soil volume (only about 1% in topsoil), the sporadic nature of mass flow and the short-range nature of diffusion, root interception is probably more important than generally acknowledged.

It is important for roots to position themselves where the other mechanisms of nutrient uptake can become effective. This is particularly apparent in very structured (distinctly blocky, prismatic, or columnar) soils where roots tend to be "clumped" between the soil structure units and nutrient problems seem to be more prevalent. Given that root growth (and with it, interception of nutrients) is critically sensitive to soil physical conditions, it follows that the effectiveness of both diffusion and mass flow must also be sensitive to soil structural and drainage conditions.

Practical implications for nutrient management

Viable root function, high root density, and long root hairs are necessary for efficient nutrient uptake from the soil. While these root features may be dependent upon rootstock characteristics, in practice, the ultimate expression of the genetic potential of root architecture will be dictated by soil structure (described earlier). Roots growing in poorly-structured soils will have less opportunity for uptake of nutrients and water via any mechanism compared to roots in more favorable conditions.

Our response to poor soil structure in a potential vineyard development site is to fracture the soil into finer fragments by deep ripping and other tillage operations and by applying soil amendments such as gypsum and compost. These measures are intended to change the physical model of the vineyard soil from that represented by Figure Vb to that of Figure IVb.

If poor or inappropriate improvement techniques are used, the resulting soil structural matrix can be as inefficient as the original. Subsequently, mis-management of the vineyard tends to degrade soil structure. Wheel track compaction, tillage pans, excessive herbicide use, poor irrigation management, and inappropriate cover crop practices all cause soil structure to deteriorate.

Inappropriate cover cropping practices are annual tillage and re-sowing of cover crops, use of tap-root annuals instead of fibrous-root perennial grasses, and excessive use of herbicides to control weeds and cover crop competition instead of mowing or slashing.

Potassium and phosphorus uptake are particularly susceptible to deterioration of soil physical properties because of their dependence upon short-range diffusion and the need for relatively high soil moisture content for diffusion effectiveness. Also, direct root contact (via root growth) which brings root surfaces close to localized nutrient sources for effective diffusion, is impaired by both high soil strength and poor drainage.

In soils dominated by sodium and magnesium, the nutrients potassium and (to a lesser extent) phosphorus, are often deficient, particularly towards the end of the growing season, because of the adverse effects of sodium and magnesium on soil structure.

Sodic soils (exchangeable sodium greater than 6% to 15% of the soil cation exchange capacity (CEC), are not uncommon in premium wine producing areas of the world including the Central Valley and Central Coast of California, southeastern Australia, Chile, South Africa, and Spain, and their adverse effects are well-known.

Magnesic soils (exchangeable magnesium greater than 40% of the CEC) are widespread, although often overlooked and their insidious nature not always understood. The deleterious effects of high concentrations of exchangeable magnesium on soil structural quality are not as well-known as that of sodium. However, both G. Grieger (1999) and J. Oster (undated) have shown that a preponderance of magnesium over calcium in soil can produce serious physical structural problems.

Magnesic soils have structural properties that resemble the model in Figure Vb rather than Figure IVb. In the wine growing areas of northern and central

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California, extreme examples of these soils are Maxwell, Henneke, and Montara series, developed from serpentine rock. In addition to these extreme examples, many other soils developed in mixed alluvium containing serpentine or serpentinized material exhibit similar properties although somewhat subdued (Bale, Clear Lake, Cole, Haire, Huichica series).

Attempts to ameliorate these and other poorly structured soils to Figure IVb status by ripping and applying gypsum and compost are often ineffective because of insufficient attention to the following heightened soil structural management demands (Cass et al. 2003):

1. Install an agricultural drainage system if needed by the soil hydrological, physical and chemical properties.
2. Plant a fibrous-root cover crop before ripping.
3. Apply gypsum, lime, compost, and other amendments strictly in accordance with the soil's physical and chemical properties.
4. Ensure that the soil is dried to the lower plastic limit before ripping or tillage.
5. Mow the cover crop before ripping, but do not disk it.
6. Rip with a winged tine at a speed of no more than 5 mph and only downhill.
7. Minimize number of ripping passes and, in particular, do not cross-rip.
8. Disk the surface of the soil to as great a depth as possible to mix amendments thoroughly.
9. Avoid trafficking rip-lines with heavy, rubber tire vehicles.
10. Sow a fibrous-root cover crop.

Consequently, the structural condition reverts to that of Figure Vb quite rapidly because of inappropriate management and the capacity of these soils to regenerate exchangeable magnesium.

Inappropriate management (Cass 2003) includes:

1. Management regimes that do not respect the soil properties, such as management for optimum canopy growth rather than management for salt-leaching in saline soils.
2. Poor control of surface water leading to prolonged saturation in winter.
3. Excessive irrigation leading to frequent, regular saturation of the soil.
4. Use of heavy (high ground pressure), rubber tire vehicles in the vineyard when the soil surface is wet or moist.
5. Failure to routinely monitor soil physical and chemical conditions in the vineyard.
6. Failure to apply an appropriate ongoing amelioration regime consistent with above monitoring.
7. Irrigation with water of inappropriate quality for the soil physical and chemical properties.
8. Routine tillage of the tractor-row area rather than use of permanent cover cropping practices.

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9. Failure to use cover crops that increase organic matter and improve soil porosity such as fibrous-root grasses rather than herbaceous species.
10. Excessive use of herbicides under the vine row leading to decline on biological activity in under vine soil and a decline in soil structural quality.

Generally, management of soil structure in vineyards is not an integral part of the nutrient management program because the connections between soil physical quality and mineral nutrient availability, movement, and uptake are not well understood.

Given the ubiquitous nature of magnesium-rich sediments in northern and central California, there is a need for an overt soil structure maintenance and improvement programs that addresses aeration, strength, and available water issues as an adjunct to nutrient management. This does not imply that available water needs to be increased in vineyards. Rather, it suggests that soil preparation for vineyard establishment and subsequent surface management should be directed towards ensuring poor aeration and excessive strength development do not limit access to and uptake of nutrients and water.

In better-designed vineyards, rootstock selection and row and vine spacing should be dictated by available water after land preparation. If the land preparation techniques fail to meet the "heightened soil structure management demands," (see above) or subsequent soil surface management is not able to maintain these physical conditions, then, available water and nutrient economy will be limited by lack of aeration and compaction. This sets in motion a pattern of deterioration which generally elicits a futile management response to excess irrigation and fertilization. Attention to the basic principles of soil structure preservation and improvement can avoid this situation. ■

Alfred Cass is a soil scientist with 40 years of teaching, research, and consulting experience in soil management for agricultural production and environmental protection, of which the last 15 years have focused largely on the soil science of premium wine production in Australia, Spain, Canada, and the U.S.

Suggested Reading

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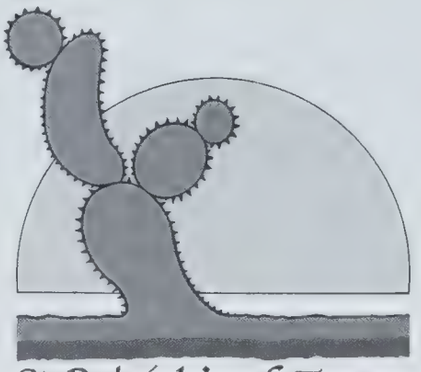

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New online registry offers one-stop shopping for grape varieties

By Amy Rafferty,
University of California, Davis

From Aligoté to Zinfandel, a listing of grape varieties and where they can be obtained within the U.S. is now available at a new website [http://ngr.ucdavis.edu] to help grape growers and researchers find appropriate grape plants. This new National Grape Registry, developed and maintained at University of California, Davis, is intended to be a user-friendly source for all grape plant material available, including wine, table, juice and raisin grapes, and rootstocks.

"The main emphasis of the site is to help growers, nurseries, winemakers, and researchers find the plant material they need," says Deborah Golino, director of Foundation Plant Services at UC Davis. "We hope the site will make it easier to find domestic sources for diverse grape varieties and clones, and to identify plant material that has been tested and certified as free of certain grapevine diseases.

"Quarantine regulations and the high cost of bringing in new grape stock from abroad make it critical for growers and researchers to be able to locate existing plant material already in the U.S."

Each of the 650 varieties listed in the registry is profiled, with information provided about its pedigree, origin, and use. Registry visitors are provided with reference material that they can consult for more information, plus listings of commercial grapevine nurseries and public grapevine collections.

The first phase of the registry is now complete. In addition to the lists of varieties and contact information for nurseries and public collections, the site has a database that allows users to enter any number of synonyms for grape names and search for the name most commonly used in the U.S.

"The synonym-search feature is the one that first-time users are the most excited about," explains Ed Stover, curator of the National Clonal Germplasm Repository and author of the proposal that initiated the project. "Many important grape varieties from the Old World have as many as 20 or 30 different synonyms. With the creation of the National Grape Registry website, there is a new, simple tool for checking synonyms from many different countries and in many different languages. This is an extraordinary solution to a problem that has vexed grape growers and winemakers for years."

During the second phase, information will be added about individual grape clones and the level of disease-testing standards required for each clone.

Funding for the registry project was provided to the UC Davis Foundation Plant Services and the U.S. Department of Agriculture's National Clonal Germplasm Repository in Davis, CA through a two-year grant from the Viticulture Consortium West and the American Vineyard Foundation. The online registry will be supported by the University of California Agriculture and Natural Resources, Foundation Plant Services, and the National Clonal Germplasm Repository of the USDA Agricultural Research Service. ■

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Describe vineyard soil types, how to manage soil treatments, cover crops, and herbicides, optimize water quality, irrigation systems. Nutrient deficiencies and toxicities, how to manage nutritional requirements. **201pp—$55.00**

Sunlight into Wine
R. Smart & M. Robinson
Canopy management and economics, improvement of canopy microclimates, importance of winegrape canopies, construction of trellis systems.
88pp—$40.00

Taming the SCREW:
A manual for winemaking with screwcaps
Tyson Stelzer
Detailed technical discussion of screwcaps and the bottle, reasons for choosing screwcaps, winemaking procedures, chemistry, bottling, capping, handling, storage, and ageing. **305pp—$90.00**

Vineyard Simple Tom Powers
Provides a clear outline with diagrams and color photos on how to build and maintain your own vineyard. **118pp—$20.00**

Viticulture, Vol. I, Resources in Australia
2ND EDITION
B.G. Coombe & P.R. Dry
With worldwide application. Soils, climates, grapevine classifications, grape varieties, phenology, rootstocks, planting material, vineyard site selection, and grape berry development.
211pp—$60.00

Viticulture, Vol. II, Practices in Australia
B.G. Coombe & P.R. Dry
Grapevine propagation, vineyard establishment, pruning, canopy management, irrigation, grapevine nutrition, grape pests, disease, and protection.
384pp—$60.00

Viticulture & Environment
John Gladstones
Site, variety, and cultural practices. Climatic analysis of Australian and world viticultural areas, new viticultural sites and possible changes in the climatic conditions.
310pp—$45.00

Wine Analysis and Production
B. Zoecklein, K. Fugelsang, B. Gump & F. Nury
A practical understanding of quick screening assays, wet chemical and instrument analysis plus results and interpretation of winemaking.
512pp—$140.00

Winegrape Berry Sensory Assessment in Australia
E. Winter, J. Whiting, J. Rousseau
How to examine berries before harvest with 20 standardized and industry-tested criteria, by judging stems, skins, pulp, and seeds.
64pp—$30.00

Wine Grape Varieties in California
edited by P. Christensen, N. Dokoozlian, M.A. Walker, & J. Wolpert
Guide to growers and vintners making decisions about variety plantings and growing practices.
190pp—$30.00

Wine Microbiology Ken Fugelsang
NEW!!! 2ND EDITION
Provides background information, step-by-step laboratory procedures, and interpretation of results. **245pp—$100.00**

Winery Planning & Design
Bruce Zoecklein, Virginia Tech
200pp in outline format CD—$95.00

Winery Utilities Planning, Design, and Operation David Storm
Describes major components of winery utility systems for planning, design, and operation.
550pp—$120.00

Winery Wastewater Handbook: Production, Impacts, and Management
J. Chapman, P. Baker, & S. Wills
Examines the chemical nature of wastewater, its impacts, how it can be handled efficiently, and disposed of responsibly. **128pp—$25.00**

PRACTICAL WINERY & VINEYARD

March/April 2007

VINEYARD SHOWCASE

EQUIPMENT IRRIGATION SUPPLIES
SERVICES GRAPE BROKERS NURSERIES

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Weed Badger Division

Weed Badger Division manufactures in-row tillers, mowers, and attachments to eliminate the worst weed nightmare without using any herbicide or hand labor. Weed Badger® gives growers effective, safe, and economical in-row weed control. Since 1979, Weed Badger® has offered solutions to in-row weed problems. Kill all the weeds, hill up, hill down, mow, sweep, rake, clean up, aerate, and incorporate amendments — all with just one machine.

One Weed Badger® replaces the work of 200 hand laborers. Destroy herbicide-resistant weeds. No more hassles, liability, or risk with dangerous chemicals. A one-time investment gives a lifetime of dependable weed control. Weed Badger® offers upgradeable models to fit every budget and grow with your vineyard.

The Model 4200 Weed Badger® Series is designed for smaller, lighter, more fuel-efficient, 18 to 30 HP tractors. This rugged model adds as little as nine inches to the tractor width when retracted. The Model 4020 fits tractors 25 to 90 HP and is equipped with an Active Cooler to keep working on long, hot days, every day. All models feature interchangeable tools and attachments.

Take advantage of excellent factory-direct service and prices. Ask for a free VHS or DVD.

For more information, contact:
Weed Badger Division,
Town & Country Research and Development, Inc.
5673 95th Ave SE, Marion, ND 58466
toll-free: 800/ 437-3392 or 701/ 778-7511
fax: 701/ 778-7501
e-mail: inquiry@weedbadger.com
website: www.weedbadger.com

PLEASE SEE WEED BADGER AD, PAGE 14.

PGT, INC.

On-Target Charged Spray Systems

On-Target offers a line of electrically-charged sprayers for growers in the vineyard, orchard, row-crop, and nursery industries. For over a decade, PGT has improved the sprayers and expanded to include the western U.S., Australia, and South America.

On-Target sprayers produce billions of electrically-charged spray drops per minute that are attracted to a plant, resulting in unequaled coverage and uniformity and radically reducing drift and runoff, which are the most wasteful and costly processes in any spray program.

On-Target sprayers are designed and fabricated in California. The stainless steel construction is compact and of the highest quality. With this design comes flexibility; unlimited adjustment capabilities for single or double row, running parallel with any trellis system for uniform coverage. Growers have found reduced application time, pesticide quantity, and risk to employees — a great advantage over traditional spraying methods.

The On-Target system has proved itself efficient and reliable, spraying more acres in a day than any other sprayer.

For more information, contact:
PGT On-Target Spray Systems
California rep: **Gary Soares**
tel: 831/595-9433
31421 SW Olympic Dr.
Wilsonville, OR 97070
tel: 503/329-8120
e-mail: info@ontargetspray.com
website: www.ontargetspray.com

PLEASE SEE ON-TARGET SPRAY SYSTEMS AD, PAGE 8.

Euro-Machines, Inc.

Euro-Machines introduced the BRAUD VL Grape Harvester in 2004. In 2007, the Braud VX series harvester has all the improvements and innovations introduced through the VL series, and the VX is larger, has more HP, and a wide 32-inch throat.

State-of-the-art technology provides top quality harvesting and full multi-function capability. The cab is sealed and pressurized for noise reduction and spray safety. A multi-function lever controls all harvester functions with pre-set picking programs and all multi-function attachments. Hydrostatic transmission with cruise control is standard.

The harvester head has a patented quick-shaker rod engagement; this enables activation of more or less shaker rods as the fruit zone requires. Variable leaf canopy of the vines, picking conditions, and grape varieties are easily handled by the operator viewing the picking process on a color monitor. Adjustments are just a fingertip away on a multi-function lever. Four highly efficient cleaning fans eliminate all leaves. For optimal cleaning efficiency, an optional patented destemmer makes it possible to destem and eliminate any MOG. The result is the cleanest fruit delivered to a winery by machine harvesting.

A large inventory of used, reconditioned, and lease-return machines is available.

For more information, contact:
Euro-Machines, Inc.
East: 540/825-5700
West: 4950 E. Fulton Dr., Cordelia, CA 94534
tel: 707/864-5800; fax: 707/864-5879
e-mail: mattateuro@aol.com
website: www.euromachinesusa.com

PLEASE SEE EURO-MACHINES AD, PAGE 36.

Vintage Nurseries

Vintage Nurseries is one North America's largest producers of dormant field-grown benchgrafts. Vintage Nurseries' advanced facility allows the greatest quality control in the industry today. Customers quickly discover that one call is all they need to receive the best value, with highest quality grapevines at the most competitive price-point in the industry. Vintage Nurseries includes hot-water-dipping, designed to eliminate vine mealybugs and other pests and pathogens, at no extra cost.

Vintage Nurseries also produces greenhouse-grown benchgrafts, rootstock rootings, own-rooted vines, and cuttings. Located in California's southern San Joaquin Valley, Vintage Nurseries propagates all plants in one of North America's best climates for a grapevine nursery.

Vintage Nurseries currently has a good inventory of popular varieties including Syrah, Pinot Noir, Cabernet, Merlot, Sauvignon Blanc, Chardonnay, and many more. Vintage Nurseries also carries the new table grape releases: Scarlet Royal, Autumn King, and Sweet Scarlet along with its selection of other table and raisin grape varieties.

All customers and industry professionals are welcome to visit the facility and growing grounds.

For more information, contact:
Vintage Nurseries
Nicholas Podsakoff , Northern CA
Western U.S., tel: 209/456-0697
Dave Haggmark, Central coast CA
Eastern U.S., tel: 805/391-0905
Mike Enns, South Valley wine grapes,
table grapes, tel: 661/747-1582
Dustin Hooper, Office sales and inquiries,
tel: 661/758-4777 x 101

PLEASE SEE VINTAGE NURSERIES AD, PAGE 82.

California Seed & Plant Lab

California Seed and Plant Lab (Cal-SPL) located near Sacramento (CA), offers plant disease testing and genetic identification of grapevine varieties. The firm was established in 1995 and employs a highly qualified technical staff (Ph.D. and MS scientists).

Disease diagnosis: Cal-SPL offers 17-virus PCR test to cover all viruses known to be present in California vineyards. Growers can identify healthy vines and start new plantings from the healthy vines. Other economically important diseases including young vine decline (*Phaeoacremonium spp*) are also identified.

Virus elimination: Cal-SPL offers meristem services to eradicate virus infections from your favorite variety.

Soil health: Cal-SPL also offers analysis of soil and enumerates beneficial microorganisms to such important pathogens as *Agrobacterium* (crown gall) and *Cylindrocarpon* (root rot). The analysis helps growers to choose a suitable organic amendment or compost tea to incorporate into soils for maximum yields.

Variety DNA identification: Genetic testing includes fingerprinting of varieties with 8-marker DNA test. Fingerprint is compared with the varietal database (Cal-SPL has all varieties grown in California in the database). Fingerprinting service can also provide genetic profiling for patent applications.

For more information, contact:
California Seed & Plant Lab
7877 Pleasant Grove Rd., Elverta, CA 95626
Parm Randhawa, Ph.D.
tel: 916/655-1581; fax: 916/655-1582
e-mail: randhawa@calspl.com
website: www.calspl.com

PLEASE SEE CALIFORNIA SEED & PLANT LAB ADS, PAGES 28, 56

Bare-Hand™ Bird Nets

Bare-Hand™ Bird Nets are the complete answer to assuring the flavor of fruit crops in the battle against bird damage. Today's premium grower manages for flavor and appearance; the essence of the harvest. This investment demands a return based on flavor quality.

Netting is far and away the most effective means of protecting fruit flavor prior to harvest, and only Bare Hand™ has the solution to fit vineyard application and help assure that the true flavor essence of the vineyard makes it to the crush pad. From single and multi-row coverage in vineyards, to overhead structures for orchards, Bare-Hand has a solution to protect valuable fruit flavor.

Think bird netting is too expensive? Bare-Hand actually reduces the cost of producing high-quality wine. Only bird netting provides complete, continuous 24/7 protection against both crop loss and bird peck damage, and Bare-Hand has the range of solutions necessary to cover vineyard application.

If you are a premium fruit producer, Bare-Hand has the investment covered! To learn more about how to FlavorGard™ a fruit crop with Bare-Hand™ Bird Nets, call today!

For more information, contact:
Bare Hand Bird Nets, c/o Plantra
4300 Obispo Rd., Atascadero, CA 93422
tel: 800/518-6872; cell: 805/610-9663
fax: 805/462-1378
e-mail: plantra@plantra.com
website: www.plantra.com

Ranch Systems LLC

In 2007, Ranch Systems expands its RanchMaster family of online, real-time data products with the introduction of the RanchMaster Weather Station (RM100-WS) for vineyards looking to track, and respond to, local climatic data.

The RM100-WS provides vineyards with temperature, wind speed, relative humidity, dewpoint, and rainfall data — collected in real-time and available over the Internet. The RM100-WS allows authorized users to open and close valves, or activate wind machines (remotely) for immediate response to local climatic changes.

Starting at $995, the RM100-WS joins the RanchMaster family of wireless nodes and sensors designed to gather sensor data from multiple points in a vineyard and transmit that information in real time back to a secure Internet site for easy access, analysis, and data management. RanchMaster systems can measure a range of vineyard conditions, including:

- Soil moisture
- Water flow
- UV radiation
- Relative humidity
- Temperature
- Dewpoint
- Windspeed
- Rainfall
- Growing Degree Days

RanchMaster plug-and-go technologies require no configuration, provide customizable alerts and reports, and offer remote irrigation control via Internet or cell phone.

A family-owned and operated business, Ranch Systems prides itself on uncompromising customer service and industry-leading, hassle-free vineyard solutions.

For more information, contact:
Ranch Systems LLC
2037 Laguna Vista Dr, Novato, CA 94945
tel: 415/408-3133; fax: 415/520-6005
e-mail: sales@ranch-systems.com
website: www.ranchsystems.com

Shur Farms
S.I.S. Frost Protection System

Shur Farms' S.I.S. (Selective Inverted Sink) Frost Protection system is a proven, effective method of frost protection for frosty valleys, pockets, and swales. It is a cold air drain, pulling in the coldest air from the vineyard floor and sending it upward 300 feet, allowing warmer air to settle downward. This award-winning, patented system has been successfully used for over 14 years in 10 countries.

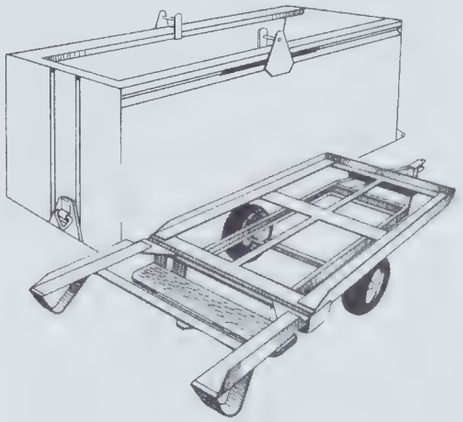
The low profile S.I.S. consists of a vertical shaft with blades spinning parallel to the vineyard floor. It is powered by either tractor-PTO or 15hp gasoline power unit, making it low-maintenance and very cost-effective. It may be used independently, or with other frost protection methods, maximizing their benefit. Most S.I.S. systems have a 100% payback in the first year of operation.

The customizable S.I.S. comes in three sizes to protect from two acres on up. It is environmentally friendly, and quiet enough to use in residential areas. For convenience, the small and midsize S.I.S. are delivered almost fully-assembled, require little site preparation, and may be removed from the field at the end of frost season.

For more information, contact:
Shur Farms Frost Protection
1890 North 8th St., Colton, CA, 92324
toll-free tel: 877/842-9688; fax: 909/825-2611
e-mail: shurfarms@earthlink.net
website: www.shurfarms.com

Western Square Industries

Western Square Industries manufactures vineyard bins, trailers, and wine barrel racks.



Western Square two-ton vineyard bins are manufactured in stainless or mild 14-gauge steel. The sides, endwalls, and bottoms are lap-welded to ensure strength and watertight integrity. The D-ring end is ribbed to transfer the stress of hoisting to the entire height of the bin end. Mild steel bins are powder-coated in a variety of colors with an FDA-approved, food-grade epoxy inside. These and other features ensure years of trouble-free use.

Western Square vineyard trailers are offered in six styles designed for narrow or wide vineyard rows. Trailer configurations accommodate two-ton harvest bins or up to three 4-by-4 plastic bins. Several styles are outfitted with ramps and plastic slides to drop bins without needing a forklift, facilitating a speedy return to the harvest. A new tilt trailer design eliminates the need for a hydraulic lifting mechanism. Simplicity of design and a durable powder coat finish contribute to easy maintenance. Add a 4-by-8 sheet of plywood and the trailer becomes a utility trailer for off-season projects.

All Western Square products are manufactured in the U.S.

For more information, contact:
Western Square Industries
Trygve Mikkelsen
1621 N. Broadway, Stockton, CA 95205
tel: 209/944-0921
toll free: 800/367-8383
website: www.westernsquare.com

PLEASE SEE WESTERN SQUARE AD, PAGE 15.

Oxbo International Corp.

Oxbo is proud to introduce the full line of Korvan mechanization equipment. The Korvan line was designed as a comprehensive, integrated set of tool carriers, attachments, and vineyard practices to help growers produce higher quality grapes at a lower cost with less labor.

For 2007, the Korvan system features three distinctive tool carriers: a tow-behind unit, a single-row tractor-mounted unit, and a double-row tractor-mounted unit. The wide product range can be easily customized for any size vineyard.

Also new in 2007 is the Korvan line of pruning attachments, including the precision rotary pruners, sprawl pruners, and sickle bar combination pruner/hedgers. There is a Korvan to fit the needs of any vineyard. The available automated opening systems, ground speed matching and precision control, set the Korvan pruners apart from others on the market.

The Korvan vineyard mechanization system also features an extensive line of attachments for canopy management, shoot thinners, vine trimmers, leaf removers, cordon brushes, and attachments for yield management.

With a complete line of vineyard mechanization equipment, Korvan now provides growers with all of the quality products needed in today's vineyards.

For more information, contact:
Oxbo International Corp.
2550 Bethel Ave., Kingsburg, CA 93631
tel: 559/897-7012; **Greg Berg** 559/859-7268
e-mail: gberg@oxbocorp.com
website: www.korvan.com or
www.oxbocorp.com

PLEASE SEE OXBO AD, PAGE 37

Kestrel Weather Meters

Vineyard managers can monitor the weather — right at the individual vine — with a Kestrel Pocket Weather Meter.

Wind speed, air temperature, relative humidity, and dew point are all important measurements in the vineyard. In the spring and fall, knowing the temperature trends and dew point is critical to determining the need for frost protection. If the air is dry (low dew point), heat loss will be greater than when the air is moist, and the threat of a radiation freeze goes up. Dew point and temperature also affect leaf wetness, which influences the development of downy mildew.

The Kestrel's wind-speed readings ensure that spraying is done safely and effectively during appropriate environmental conditions.

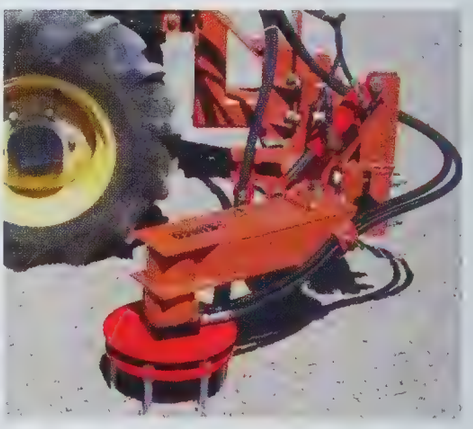
A Kestrel Pocket Weather Meter is also a valuable tool when planning a vineyard. Tracking conditions at potential vine locations can help develop an accurate understanding of a property's microclimates and select the varietals and growing sites that will ensure success.

For more information, contact:
Kestrel Weather Meters
21 Creek Circle, Boothwyn, PA 19061
tel: 610/447-1555, fax: 610/447-1577
email: info@nkhome.com
website: www.nkhome.com

Kimco Mfg., Inc.

Kimco Mfg., Inc. has introduced the TB-1 in-row tiller (requested by many small vineyard growers), the newest addition to Kimco Mfg., Inc.'s line of mechanical in-row weed control equipment.

Drawing on 30 years of mechanical in-row weed control experience, Kimco has designed the TB-1 specifically for a small grower (1 to 15 acres). The new in-row tiller will enable a small grower to mechanically control in-row weeds in much the same way as a large grower does. This allows adaptation of organic or sustainable cultural practices while minimizing hand labor. Balancing cost with necessary functions, the TB-1 is available in kit form that costs about 60% **less** than heavy-duty complete machines.



Complete assembly instructions with photos are supplied with each kit. It is also available in any stage of completion desired, up to nearly fully assembled and powder coated. The TB-1 can be mounted on the front, middle, or rear of a tractor and is powered by tractor hydraulics with a fender-mounted control valve. Mounted to standard 2¼" square toolbar material, the TB-1 can be adapted to almost any tractor. The TB-1, in all forms, comes complete except for hydraulic hoses and tractor mount.

For more information, contact:
Kimco Mfg., Inc.
9200 W. Barstow Ave, Fresno, CA 93723
tel: 559/277-9300; fax: 559/277-9358
e-mail: sales@kimcomfg.com
website: www.kimcomfg.com

PLEASE SEE KIMCO MFG. AD, PAGE 84.

Hydrolysate Company of America

The world is changing, with news reports showing the impact of our actions on the environment every day. Organic products are now coming into the mainstream, and educated consumers are looking for organic products which will outperform synthetic counterparts.

Multi Bloom

Multibloom is just such a product for use in vineyards to enhance the growth and development of well-balanced vines, and produce high-quality winegrapes. It promotes soil biodiversity, key to creating healthy root zones and soil fertility. Vines benefit from this increased biodiversity, and the *bacillus* in the Multibloom product.

Using Native American knowledge from hundreds of years ago, combined with modern technology and scientific research, Multibloom was developed. Made from 100% catfish protein, it contains over 13% amino acids, which can readily be absorbed by leaves and roots, and *bacillus* that will multiply and improve soil micro-activity. Multibloom contains **no** heavy metals or salts.

Two to three foliar sprays of Multibloom early in the growing cycle will ensure high sugar content with uniform ripening at veraison. High-quality winegrapes; 100% money-back guarantee.

For more information, contact:
Hydrolysate Company of America LLC
2367 Brant St., Arroyo Grande, CA, 93420
tel: 805/474-8562; toll-free: 877/964-2887;
mobile: 650/280-6278
fax: 805/474-8531
e-mail: edzybura@charter.net
website: www.multibloom.com

SureHarvest, Inc.

As competitive pressures intensify, winegrowers must optimize quality, control costs, and distinguish themselves in the marketplace. SureHarvest helps winegrowers address these critical needs through information technologies and professional services.

Information Technologies — *SureHarvest for Vineyards* is a fully-integrated vineyard information system available as a package or individual modules including: sampling/scouting, canopy, pest, nutrition, soil, water, quality, contract, and harvest management. Each system is tailored to your operation. The software is used on more than 47,000 winegrape acres in California, Washington, and Oregon.

SureHarvest also provides website and online technologies. See *sustainablewinegrowing.org*, the online environment for the California Sustainable Winegrowing Program (SWP), for an example.

SureHarvest
SUSTAINABILITY SOLUTIONS

Sustainability Professional Services — SureHarvest offers sustainability program management professional services to trade associations and companies. In 2001, the Wine Institute and California Association of Winegrape Growers (CAWG) contracted SureHarvest to lead development of the SWP. SureHarvest continues to work with CAWG, Wine Institute, the California Sustainable Winegrowing Alliance, regional associations, and private companies on sustainability program strategy and implementation.

For more information, contact:
SureHarvest, Inc.
2901 Park Ave. Suite A2, Soquel, CA 95076
tel: 831/477-7797; fax: 831/477-7790
e-mail: sales@sureharvest.com, or
pmitchell@sureharvest.com
website: www.sureharvest.com

PLEASE SEE SUREHARVEST AD, PAGE 16.

A&J Vineyard Supply

Heading into its fifth year of providing quality vineyard supplies and service, A&J Vineyard Supply is optimistic about the future. "We work in a great industry," say owners Augusto and Jennifer Di Battista. "Our customers love what they do and so it's a pleasure to help make sure they get the right products and services, when they need them, to get the job done."

A&J Vineyard Supply

With an extensive on-site inventory and convenient St. Helena, CA location, A&J Vineyard Supply has become a leading source for vineyard trellising and supplies. In addition to mainstay items such as line posts, t-posts, end posts, wire, crossarms and training rods, A&J also provides specialty items such as custom-welded Open Lyre and GDC systems.

"Quality and timing are still the key," confirms Rey Sanchez of the A&J sales team.

"We appreciate what it means to have a crew waiting for materials, and the value of time, especially in agriculture," adds colleague Cliff Little. "That's why we've been working very hard over the past year to solidify our relationships with mills and other suppliers to insure that we can come through for our customers."

For added convenience, A&J also provides delivery service.

For more information, contact:
A&J Vineyard Supply
Cliff Little: 707/477-9002
Rey Sanchez: 707/591-4022
900 N. Crane Ave., St. Helena, CA 94574
tel: 707/963-5354; fax: 707/967-8242
website: www.aj-vineyardsupply.com

PLEASE SEE A&J VINEYARD SUPPLY AD, PAGE 24.

Sunridge Nurseries, Inc.

Sunridge Nurseries Inc., a full-service nursery, has been providing top-quality grape nursery stock to the wine and table grape industries for over 30 years. Many different varieties and clones grafted on your choice of rootstock are available and all material is hot water-dipped to ensure pest-free, high-quality vines. Sunridge is an official ENTAV licensee. New introductions include: Cabernet Sauvignon 412 and 685, Pinot Noir 943, and Sauvignon Blanc 297. Horticultural experts are on staff and available to serve your vineyard.

Sunridge Nurseries offers an affordable plant protector to protect young vines from herbicide sprays, small animal feeding, and wind damage. When planting dormant vines, the top of the plant protector can be closed to simulate a greenhouse environment that enables vines to push buds without drying out. Once the roots take hold and the vine buds push, the plant protector can be opened or unsealed quickly (no shovel needed) and simulates a common grow tube. Costly expenses due to mounding are avoided.

Contact Sunridge Nurseries today to satisfy all vineyard planting needs.

For more information, contact:
Sunridge Nurseries, Inc.
North Coast: **Michael Monette**
707/975-3646, vineguy@sonic.net
Central Coast: **Andrew Jones**
805/234-4920, arjones70@hotmail.com
Central Valley / Outside CA: **Mike Thomas**,
559/217-9778, vinemaker@aol.com
South Valley / Table Grapes: **David Mann**,
661/978-5696, dmann@sridge.net
441 Vineland Rd, Bakersfield, CA 93307
tel: 661/363-VINE (8463); fax: 661/366-4251
website: www.sunridgenurseries.com

PLEASE SEE SUNRIDGE NURSERIES AD, PAGE 84.

Joseph W. Ciatti Company LLC

Joseph W. Ciatti Company is the wine industry's oldest, largest, and most comprehensive grape and bulk wine brokerage in the U.S. and internationally. Annual sales are over 110 million gallons (416 million liters).

Wine brokerage services include: grape contracts; grape processing contracts; complete negotiations of bulk wine purchasing and sales; tasting, blending, and finishing wines by on-staff enologists; objective information, including comprehensive long-term market analysis; evaluation of inventory quality and current market values; and locating unlabeled case goods or wine for private labeling.

The Ciatti Company has the most extensive and up-to-date product line of premium varietals; generic wines; grape and fruit concentrates; brandy and high proof from grape, citrus, and grain. Internationally, Ciatti brokers exports of U.S. wines to overseas markets and imports of foreign wines to California labels and wineries, including wines from Australia, Chile, France, Argentina, and other major wine growing regions, including South Africa.

John Ciatti, Greg Livengood, and John White specialize in premium coastal varietals and share responsibility of all California wineries. Chris Braun and Dennis Schrapp cover international markets and wineries outside California. Glenn Proctor and Johnny Leonardo are responsible for brokering grapes and assist with California wineries. Andy Bivona and Greg MaGill specialize in varietal juices and concentrates, beverage alcohol, and all natural grape colors.

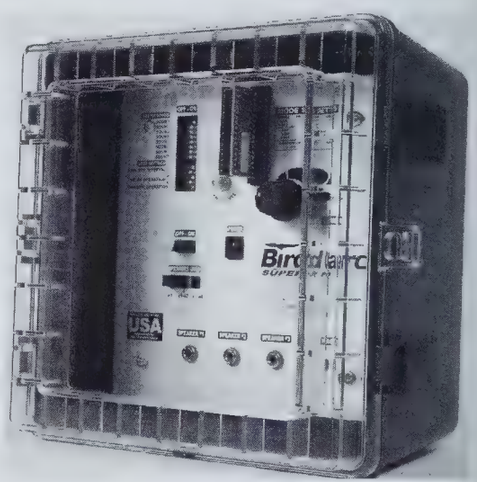
For more information, contact:
Joseph W. Ciatti Company, LLC
1101 Fifth Ave. #170, San Rafael, CA 94901
tel: 415/458-5150; fax: 415/458-5160
e-mail: reception@ciatti.com
website: www.ciatti.com

PLEASE SEE JOSEPH W. CIATTI AD, PAGE 21.

Bird Gard, LLC

"Bird Gard" electronic bird repelling products drive unwanted birds away from orchards, vineyards, crops, airports, landfills, and anywhere birds are a problem. Audible bird distress and harassment sounds are digitally recorded onto a microchip and are effective against starlings, robins, grackles, seagulls, woodpeckers, and other pest birds. These sounds are then amplified and broadcast to protect areas from one acre (0.4 hectares) up to 30 acres (12 hectares).

The new Bird Gard Super Pro PA 4 introduces fully digital random operation throughout, and is designed to use low frequency sounds to drive away wild turkeys, deer, heron, egrets, and other mammals. Protects up to six acres. Bird Gard products include a one-year customer satisfaction guarantee. Manufactured in the U.S.A.



For more information, contact:
Bird Gard, LLC
PO Box 1690, 254 W. Adams Ave.
Sisters, OR 97759
tel: 541/549-0205; toll-free: 888/332-2328
fax: 541/549-5286
e-mail: info@birdgard.com
website: www.birdgard.com

Dow AgroSciences LLC

New vineyard plantings should provide decades of productivity. Considering the massive undertaking and expense of planting a new vineyard, soil fumigation is strongly advised where nematodes or "replant disease" are present.

Telone®

Everything grows better.™

Soil fumigation using Telone® soil fumigant creates a zone of protection around roots, allowing them to develop in an environment where nematodes are controlled and soil-borne diseases and viruses (such as grape fanleaf virus) are managed. The result: extensive, healthy root systems capable of producing decades of high-quality, high-yielding grapes.

The increased growth provided by Telone® (compared to untreated) is so dramatic that the cost of fumigation is often paid for with the first crop harvested. Plus, starting vines with a healthy, strong root system leads to many other benefits such as generating early growth response, promoting plant longevity, creating more efficient use of water and fertilizer and allowing for more rootstock choices.

To order the FREE guide, *Managing Nematodes and Replant Disease in Orchards & Vineyards,* call 888/395-PEST.

For more information, contact:
Dow AgroSciences LLC
9330 Zionsville Road, Indianapolis, IN 46268
tel: 888/395-PEST
website: www.dowagro.com

Hardi North America

Hardi Arrow hydro-pneumatic and pneumatic sprayers are unique air systems designed to conquer mildew and botrytis in vine and berry crops. With four individual spouts pointing to the canopy, the Arrow B11 can be set up to cover any type of canopy from vertical to full overhead trellis, in tractor rows from 5 to 12 feet wide, with single or two-row machines.

By spraying from more directions into the canopy, the B11 generates cross-flow turbulence inside the canopy, and the spray droplet cloud gives better coverage. Drift is reduced as the spouts direct the air and the spray to where it is needed and nowhere else. The amount of air is adjusted according to growth conditions via a two-speed gearbox.

HARDI

Versatility in spray rates from seven gallons per acre with full pneumatic spouts, to 400 gallons per acre with semi-pneumatic spouts, covers a range no other sprayer does. Three points per unit in 105 and 155 gallons, trailers in 270, 400, 600, 925 gallons. All with full two-year warranties and 10-year tank warranties.

Hardi is the largest spray equipment manufacturer in the world, headquartered in Denmark, with local manufacturing in Visalia, CA. Visit us on the web at www.hardi-us.com or www.hardi.com.

For more information, contact:
Hardi North America
1500 West 76th St, Davenport, IA 52086
Hardi West Coast
8550 West Roosevelt, Visalia, CA 93291
tel: 559/651-4016 fax: 559/651-4160
email: gjk@hardi-us.com
website: www.hardi-us.com or www.hardi.com

PLEASE SEE HARDI AD, PAGE 85.

Spec Trellising

Spec Trellising, a family-owned and operated trellis supply company, works closely with customers and meets their needs with high-quality trellis materials and trellis-related products at a reasonable cost, with first-rate service.

SPEC TRELLISING

Spec recommends only top-quality, long-lasting trellising materials for grapevine trellising. While lower-quality products can undoubtedly be found, it is Spec's sincere belief that trellis construction is a laborious, costly task that should be done right the first time, using only the finest products. Research indicates that good, sound canopy management is critical to formation of high-quality fruit, and begins with proper materials.

Spec's diversified product line includes everything grapegrowers need to trellis and train vines, and to manage canopies. The company's products are among the best of their kind in the world, and include steel posts, hi-tensile wire, vine shelters, bird netting, vine-tying products, and more.

NEW for 2007: The Prothec System, a patented system consisting of Prothec pliers and degradable Prothec ties. The unique design of the Prothec tie combines large width with expandable embossed finish, which prevents girdling and other vine damage. The Prothec system allows growers to quickly secure vines to trellis wires by twisting and cutting the expandable tying material in one quick action. Spec offers four different grades of Prothec tying material.

For more information, contact:
Spec Trellising
39 Indian Dr., Ivyland, PA 18974
tel: 800/237-4594, or 215/322-5588
fax: 215/357-3122
e-mail: info@spectrellising.com
website: www.spectrellising.com

PLEASE SEE SPEC TRELLISING AD, PAGE 28.

Duarte Nursery, Inc.

Choose Duarte Nursery Big Pot Benchgrafts for your vineyard; measure the quality by their performance. Duarte offers Big Pot Benchgrafts with a guaranteed stand and free delivery in most of California and Oregon.

Duarte offers one of California's best vineyard service teams. A Duarte viticultural consultant is available to provide sales and service throughout California and Oregon grapegrowing regions.

DUARTE TREES & VINES

With the use of Big Pot Benchgrafts and consultation from Duarte's vineyard service team, you're guaranteed a successful planting.

Duarte defines quality as your complete satisfaction.

For more information, contact:
Duarte Nursery, Inc.
1555 Baldwin Rd., Hughson, CA 95326
tel: 209/531-0351; fax: 209/531-0352
e-mail: sales@duartenursery.com
website: www.duartenursery.com

PLEASE SEE DUARTE NURSERY AD, PAGE 34.

Korvan Grape Harvesters

Korvan grape harvesters are American-made and backed by a commitment to customer service and parts availability. This commitment has enabled Korvan to continually be a top-selling grape harvester in the U.S. wine, raisin, and juice market.

For 2007, Oxbo has improved the Korvan 4012 multi-function grape harvester with a 275hp turbo-charged John Deere engine. The Korvan 4012 features a chassis designed to harvest and spray, and to perform other vineyard tasks. It also utilizes a patent-pending ground-drive system that enables it to maneuver in some of the most extreme hillside conditions.

Using grower suggestions, Korvan design engineers continue to improve the line of standard grape harvesters. The 3016XL now features easy-change rod holders, improved lower stick-kickers, improved steering lights, and two-wire hydraulic hoses throughout the machine.

You can trust a Korvan harvester to deliver high-quality fruit. All Korvan harvesters utilize a soft-touch bow rod harvesting system and bucket conveyance system that gently carries grapes to the gondola, giving clean, whole fruit. Because Korvan harvesters don't drag your grapes, Korvan picks the fruit that winemakers love.

For more information, contact:
Korvan Grape Harvesters
270 Birch Bay Lynden Rd.
Lynden, WA 98264
toll free: 888/6-KORVAN
Mitch Ritchie 559/285-5804, or
Jon Olson 360/815-1551
e-mail: korvan@korvan.com
website: www.korvan.com

PLEASE SEE OXBO AD, PAGE 37.

Ty-*n*-Gro™ Premium Tie tape

Superior performance for plants

Ty-*n*-Gro™ is the grower's choice for premium tie tape. Ty-*n*-Gro's proprietary blend of stretch and strength ensures that planted stock is supported safely and securely.

Ty-*n*-Gro safely expands as plants grow, is secure, and offers rapid, easy application by hand or tying machine.

Hassle-free use for growers

Premium Tie Tape

Ty·n·Gro™

By the roll, Ty-*n*-Gro's Color Core™ system means no more guessing the gauge of half-used rolls. Each tape gauge is also clearly printed inside every core.

By the HandiStak™, Ty-*n*-Gro's exclusive multi-roll wrapping ensures that every roll stays tightly rolled until you need it.

By the carton, Ty-*n*-Gro's color-coded cartons tell you at a glance what type of tape you have. Bar codes provide quick and easy inventory. Three types to choose from: Hand Tie Tape (green box); Embossed Machine Tape (red box); and Budding and Grafting Tape (blue box).

Because growing challenges are many, Ty-*n*-Gro comes in a range of sizes and gauges designed to *grow* the bottom line with unbeatable performance and economical pricing.

For more information, contact:
Ty-*n*-Gro, c/o Plantra
4300 Obispo Rd., Atascadero, CA 93422
tel: 800/518-6872; cell: 805/610-9663
fax: 805/462-1378
e-mail: plantra@plantra.com
website: www.plantra.com

*PLEASE SEE TY-*n*-GRO AD, PAGE 7.*

AgCode

AgCode has designed an information management solution to meet the unique needs of the vineyard industry. AgCode's Total Ranch Solution is a complete field data collection system featuring the premier field payroll solution in the industry, including payroll data collection and pay rule processing.

AgCode's Total Ranch also includes production planning and budgeting, resource data collection (including equipment and chemical), viticulture scouting, and phonology tracking.

AgCode's full-reporting suite allows users to go from "dock to doc" by docking the handheld to sync data to the web and creating documents tailored to their needs.

AgCode

By combining Windows mobile technology, bar code scanning, GPS technology, secure Web-based data systems and AgCode's Command Code technology, AgCode has made payroll and production data collection more efficient and precise.

AgCode's premier payroll solutions allow supervisors to record time and productivity of a field labor force and collect information on the worker, crop harvested, or application performed while in the field. Payroll data is collected in the field using Windows CE handheld technology then synced to a secure web-based site where pay rules are calculated and hours can be viewed, audited, and approved for export into any back-office software.

For more information, contact:
Agcode, Inc.
800 Industrial Park, Hwy 28
Starbuck, MN 56381
tel: 877/250-8435; fax: 320/239-4067

PLEASE SEE AGCODE AD, PAGE 14.

Central Valley Builders Supply

CVBS opened its doors in 1955 to supply building materials to surrounding builders. Since then, CVBS has grown into one of the largest suppliers of vineyard products and equipment in the industry.

CENTRAL VALLEY BUILDERS SUPPLY
AGRICULTURAL DIVISION

The CVBS Agricultural Division is a complete supplier that carries a large assortment of trellising, fencing, irrigation, drainage, erosion control, pruning, spray, Macro bins, harvest supplies, and much more. Please visit the website, www.cvbsupply.com, for a complete list of suppliers and links, or call one of our three locations.

In 2006, CVBS grew again by opening its fifth overall location (3rd store focused on ag products) in Healdsburg, CA. Healdsburg is a 10,000 sq ft. store with a 1.5-acre materials yard, completely designed around everything an agricultural customer would need.

As CVBS expands into new territories, the commitment continues to be the same: A total vineyard supplier that is responsive, flexible and creative in solving customer needs. With a distribution facility and a fleet of delivery trucks, CVBS Ag Division has the materials customers need, with the ability to deliver the product where customers need it most, on the job, and on time.

For more information contact:
Central Valley Builders Supply
1100 Vintage Ave., St. Helena, CA, 94574
tel: 707/967-4300; fax: 707/963-8952
1790 Soscol Ave., Napa, CA, 94559
tel: 707/257-8888; fax: 707/261-2962
160 Grant Ave., Healdsburg, CA, 95448
tel: 707/473-9722; fax: 707/473-9688

PLEASE SEE CVBS AD, PAGE 40.

JMS Flower Farms, Inc.

JMS Flower Farms offers JMS Stylet-Oil and Organic JMS Stylet-Oil to winegrape growers. The food-grade white oil formulations are valuable tools for growers interested in economical, effective pest control in the vineyard.

Organic JMS Stylet-Oil is approved for organic use, and is OMRI-certified. Both products, referred to as "Stylet-Oil," control powdery mildew and botrytis. Working as an eradicant and preventative, Stylet-Oil kills powdery mildew on contact, and maintains control in a 10-to 14-day spray interval.

University-tested on grapes for 14 years, Stylet-Oil is recognized by leading researchers, including Dr. Doug Gubler of UC Davis, and Dr. Wayne Wilcox of Cornell University (NY) as one of the best eradicants of powdery mildew, and one of the few "soft" materials to control powdery mildew. Stylet-Oil can replace sulfur sprays for powdery mildew control. A four-hour reentry interval, and 0 days pre-harvest interval, allows workers safely and quickly back into vineyards, with no sulfur irritation.

Stylet-Oil controls plant-feeding mites, mealybug, scale, and leafhoppers. Stylet-Oil is tank-mixable with most fungicide, insecticide, or foliar sprays (10-day interval with sulfur and 14 or more with Captan), allowing flexibility in integrating this material into your spray program. While effective on a broad range of pests, Stylet-Oil is not harmful to populations of beneficial insects. Economical and biodegradable, Stylet-Oil is a plus for grape growers seeking safe, effective pest control programs.

For more information, contact:
JMS Flower Farms, Inc.
4423 5th Place SW, Vero Beach, FL 32968
tel: 772/562-8770; fax: 772/562-7202
e-mail: styletoil@aol.com
website: www.stylet-oil.com

PLEASE SEE JMS STYLET-OIL AD, PAGE 33.

California Grapevine Nursery, Inc.

California Grapevine Nursery, certified by the California Department of Food & Agriculture, provides grapegrowers with high-quality planting materials. Available products include dormant rootstock and dormant grafted vines, at very competitive prices.

Choose from 21 varieties of certified rootstock including the French-developed Gravesac variety. A large selection of scion varieties and clones, including ENTAV-INRA® clones to customize your grafted-vine order, is also available. California Grapevine Nursery is a licensed agent of ENTAV-INRA® material in the U.S. with authentic clones from France.

CALIFORNIA GRAPEVINE NURSERY

California Grapevine Nursery employs state-of-the-art nursery practices to assure clean, healthy, and productive grapevines. An integrated pest-management program is utilized to carefully monitor vines and treatments are applied only when absolutely necessary. An integrated fertilization program provides vines with proper nutrition along with preplant soil conditioning. All vines are hot water-treated at no extra charge.

California Grapevine Nursery is dedicated to providing customers with the highest quality plants available and excellent, efficient customer service.

For more information, contact:
California Grapevine Nursery, Inc.
1334 Vidovich Ave., Suite A
St. Helena, CA 94574
tel: 800/344-5688; fax: 707/963-1840
e-mail: sales@californiagrapevine.com
website: www.californiagrapevine.com

PLEASE SEE CAL GRAPEVINE NURSERY AD, PAGE 19.

Grow Smarter, Inc.

Premiere Viticultural Services has identified a strategic partner to enhance the PremiereVision application and to develop additional solutions for the vineyard. The company, "Grow Smarter, Inc.," will benefit current customers by continually improving the technology, and developing new products and partnerships to meet the needs of winegrowers worldwide.

Jim Verhey, Premiere's CEO, says, "Joint venturing with a focused technology company is the best way to realize the full value of PremiereVision for the benefit of our current and future customers."

Grow Smarter's enhancements have aligned PremiereVision with the latest generation of Internet-based applications. PremiereVision's benefits include: ease of set up and use (users only need an internet connection); frequent enhancements; and simple interaction with other systems, like payroll and accounting applications. Another advantage is the system's low total cost of ownership, as clients are not required to buy additional hardware, pay for software maintenance, or hire IT consultants.

"Using PremiereVision is like leasing a car with the torque of a truck, the comfort of a minivan, and the fuel efficiency of a hybrid," says Miguel Guevara, president of Grow Smarter. "The lease terms enable our clients to trade-up to the latest model as soon as it is available; this is sometimes every week!"

Grow Smarter's vineyard management solutions enable winegrowers to increase quality and uniformity, manage costs, and improve operations. The company currently supports nearly 5,000 acres and 200 users in the U.S., Mexico, Chile, Argentina, and France.

For more information, contact:
Grow Smarter, Inc.
855 Bordeaux Way, Ste. 100, Napa, CA 94558
tel: 707/320-8126
e-mail: miguel@grow-smarter.com
website: www.grow-smarter.com

PLEASE SEE GROW SMARTER AD, PAGE 48.

Agajanian Vineyards

Agajanian Vineyards Wine Grape Brokerage provides a variety of services to satisfy its customers' varied needs.

Winery Services: Wine grape procurement: Agajanian Vineyards assists in finding exceptional values on wine grapes throughout California on a brokerage or a full-service basis and helps assure customers the grapes to fulfill market demand.

Wine Grape Inspections: Save valuable time during harvest and let Agajanian Vineyards provide on-site field inspections. Only through inspection will assure that customer quality needs are met on existing contracts and on any new grapes purchased. Most importantly, Agajanian's sole focus is to help enhance wine quality, and control costs.

Grower Services: Grapes for Sale listing: Available wine grapes are listed and, once contacted by winery clients, the Agajanian Vineyards' data base will be accessed for a match (no charge).

Grape Marketing: To find the best possible market for wine grapes, list the grapes as above, and Agajanian Vineyards will actively market the grapes by:

- Presenting grapes in a professional manner to wineries throughout North America;
- Promoting the grapes through advertising, fax, and email campaigns, direct mail, telephone, and personal meetings;
- Saving customer-time finding qualified buyers,
- Giving customers market feedback;
- Assisting customers with long-term planning.

For more information, please contact:
Agajanian Vineyards
North Coast: Chris Lindelof
tel: 707/894-1828; cell: 707/696-7164
California: Gary Agajanian
4582 W. Jacquelyn Ave., Fresno, CA 93722
tel: 559/271-2426; fax: 559/271-2094
cell: 559/351-9354
e-mail: gary@agajanian.com
website: www.agajanian.com

PLEASE SEE AGAJANIAN VINEYARDS AD, PAGE 89.

Terra Spāse, Inc.

Terra Spāse offers state-of-the art technical solutions to soil- and climate-based problems for existing and new vineyard development projects. The Soil Information System™ (SIS) has been used in over 4,000 acres for vineyard site analysis, terroir mapping, design and development planning, vine nutrition and irrigation scheduling, and vineyard problem resolution.

SIS combines patented, state-of-the-art soil physical data collection technology (texture, compaction, water holding capacity) with chemical analysis, to create the most detailed and accurate maps of soil variability commercially available. Products include soil maps for vineyard layout, drainage and irrigation system design, varietal and rootstock selection, soil preparation (ripping depth), and pre-plant soil amendment and fertilizer applications.

Soil Vigor Potential Plus™ and zone maps for individual and combinations of soil nutrients, are used in existing vineyards for trouble-shooting stressed or under-performing sections of individual blocks, and to direct canopy management, fruit thinning, and selective harvest decisions. Plant-available moisture maps are used to optimize sensor placement (probes and P-bombs), and improve vineyard efficiencies for water usage and data collection.

Other Terra Spāse information products include near real-time North Coast weather data (including maximum, minimum, and average temperature and ppt), vineyard-specific measurements of vine water status, soil moisture status, and NDVI maps of vine canopy density. Weather and disease (powdery mildew and *botrytis*) risk maps for Napa and Sonoma counties are available by subscription online at www.terraspase.com.

For more information, contact:

Terra Spāse, Inc
345 La Fata St. Ste. D, St. Helena, CA 94574
tel: 707/967-8325; fax: 707/967-8596
e-mail: terraspase@earthlink.net
website: www.terraspase.com

PLEASE SEE TERRA SPASE AD, PAGE 25.

Turrentine Brokerage

If you've been around the vineyard block a few times, you know the importance of a trusted advisor. Turrentine Brokerage knows the wine business inside and out. If you deal with wine and grape supplies, if you need to buy or sell grapes or wines in bulk, you need Turrentine Brokerage.

Call Turrentine Brokerage for win/win negotiations, personal service, and a comprehensive selection of premium wines and grapes. A UC Davis-educated winemaker and a Fresno State-educated viticulturist are on staff. Ask about the **Turrentine Collateral Value Report**, inventory appraisal service, and the often-quoted **Market Update** newsletter for in-depth analysis of the grape and wine markets.

TURRENTINE
GRAPES & WINE

Turrentine has an unparalleled record of predicting wine business trends, and helping clients profit from them. Turrentine knows the sources of supply, history and capabilities, the brands, people and finances. Turrentine earns trust and guards confidences carefully; makes deals happen; bring businesses together efficiently, creatively, and quickly. Turrentine understands the key factors that make your business tick. They know how to avoid many hidden disasters.

Explore the Turrentine website, check the company's track record and give them a call.

Strategy, Action, Profit!

For more information, contact:

Turrentine Brokerage
Steve Fredricks, Vice President/Partner
Michael Robichaud, Broker/Partner
Brian Clements, Partner
Larry Kavanagh, Broker
Erica Moyer, Broker
Bill Turrentine, President/Partner
Matt Turrentine, Broker
Steve Robertson, Broker
7599 Redwood Blvd. Ste. 103
Novato, CA 94945
tel: 415/209-9463; fax: 415/209-0079
e-mail: Info@turrentinebrokerage.com
website: www.turrentinebrokerage.com

PLEASE SEE TURRENTINE BROKERAGE AD, PAGE 29.

Jump Start™ Grow Tubes

Pick your grapes one year earlier!

Growers who use Jump Start™ grow tubes often pick their first commercial crop one year earlier, and ramp up to full yield levels two to three years faster because Jump Start grow tubes promote faster, healthier growth:

- By reducing moisture and light stress;
- By allowing full leaf expansion for photosynthesis;
- By filtering sunlight to provide the optimal ratio of red, far red, and blue light, for ideal balanced growth — above and below ground.

Jump Start's large, plant-safe 3.5 inch-diameter, exclusive "Peach" color, and light-diffusing twin-wall construction grow your bottom line by:

- Automatically and uniformly guiding vines up to the cordon wire, saving multiple trips through the field to train vines;
- Shielding young vines from weed control spray and from mechanical in-row cultivators;
- Protecting young vines from animals, especially rabbits and deer, until they are safely trained on the cordon wire;

Jump Start™
GROW TUBES

- Reducing vine stress, increasing survival rates and dramatically reducing costly re-plants.

The Jump Start Grow Tube design team of Joe Lais, Chris Siems, and Steve Tillmann have more than 40 years' combined experience in grow tube design, production, and use. Let their experience get your vineyard off to a healthy and profitable start!

For more information, contact:

Jump Start Grow Tubes c/o Plantra
4300 Obispo Rd., Atascadero, CA 93422
tel: 800/518-6872; cell: 805/610-9663
fax: 805/462-1378
e-mail: plantra@plantra.com
website: www.plantra.com

PLEASE SEE JUMP START AD, PAGE 52.

Kendall-Jackson Nursery

Kendall-Jackson Wine Estates raised the bar of nursery quality in 1993 when it opened an in-house nursery to customers throughout the industry. "The Madera, CA nursery has become one of the nation's largest grapevine resources since it opened in 1993," says Ernie Bowman, nursery general manager.

"We do things our own way from start to finish because we are so focused on, maybe even a little obsessed with, quality," he adds. "Our quality is second to none in the industry."

The nursery has prized scionwood cuttings from some of California's choicest vineyards, including those on Mt. Veeder in Napa County, and Alexander Mountain Estate in Sonoma County.

One key to quality at the nursery is a trellised rootstalk block. Trellising, the exception rather than the rule at most nurseries, gets the rootstalk off the ground for ideal sun exposure, reduces pest and fungus pressures, and encourages straight cuttings for grafting.

Vines are custom-cultivated to meet various requirements in terms of disease resistance, vigor, and drought tolerance. Dormant benchgrafts, dormant rootings, green benchgrafts, and green quick-starts are available. The nursery accepts custom orders and offers free delivery for orders of more than 10,000 vines.

Additional information about the nursery and its products is available at the Kendall-Jackson website: www.kj.com.

For more information, contact:
Kendall-Jackson Nursery
Ernie Bowman, General Manager
1190 Kittyhawk Blvd., Santa Rosa, CA 95403
tel: 707/836-2021; fax: 707/836-2266
website: www.kj.com

PLEASE SEE KENDALL-JACKSON NURSERY AD, PAGE 55.

Bird Gard/JWB Marketing LLC

The Mega PRO has 120 decibels of output and covers 30 acres. It is 60 times more powerful than the Bird Gard Super PRO II that covers up to six acres. Included with the mega PRO are a 200-watt amplifier, a 20-speaker tower, and a 40-watt solar panel. List: $3,000; Discount: $2,400.

What vineyard managers say about the Mega PRO:

"Had the starling flocks been there, we would have lost $20,000 to $30,000 worth of grapes." Jack Keller, Hazlitt 1852 Vineyards, New York.

"All the birds just left … no birds returned. We even stopped using cannons. The Mega PRO really did a great job!" Bob Kidston, Dykeview Farms, Nova Scotia.

"The Mega PRO paid for itself the first season because of the money we saved on bird patrols and pyrotechnics." Daryl Salm, Valley Farm Management, California.

For more information, contact:
Bird Gard/JWB Marketing LLC
Jim Burton
2308 Raven Trail, West Columbia, SC 29169
tel: 800/555-9634; fax: 803/796-0654
website: www.birddamage.com

Ray Carlson & Associates, Inc.

Did you know that you could increase the profitability of your vineyard using GIS?

GIS — How can you manage it if you haven't measured it? A Geographic Information System (GIS) ties maps to a database.

Ray Carlson & Associates have vineyard consultants, PCA, and a GIS team on staff to help you:

- **Organize** your data — and obtain vital knowledge from key personnel,
- **Prepare** for regulations — governmental or environmental,
- **Improve** management, your product, and your team using GPS to locate critical utilities.

… And much more!

Mapping — Appellation Custom, color Appellation maps, showing your winery or vineyards, are a unique marketing tool. Ray Carlson & Associates also has aerial photo and mapping resources ready to create a map that is distinctly yours.

Surveying — Did you know that a current survey might help you increase the value of your property?

Ask how!

GPS — Ray Carlson & Associates uses the latest technology, but believes that high-tech will never replace high-touch.

Ray Carlson & Associates combines a variety of high-quality products with dedication to customers and their needs, and have been surveying and mapping land in Sonoma county and surrounding California counties since 1976.

For more information, contact:
Ray Carlson & Associates, Inc.
411 Russell Ave., Santa Rosa, CA 95403
tel: 707/528-7649; fax: 707/571-5541
e-mail: sara@rcmaps.com
website: www.rcmaps.com

PLEASE SEE RAY CARLSON & ASSOC. AD, PAGE 83.

Advanced Viticulture

Advanced Viticulture LLC is a consulting service for wineries, winemakers, and winegrowers who are dedicated to producing premium wine products. Advanced Viticulture is operated by Dr. Mark Greenspan. He has 18 years of scientific research and viticultural experience, and specializes in irrigation and nutrition management, yield and canopy management, vineyard climate, fruit maturation, and viticultural technologies.

AV Advanced Viticulture

Services include, but are not limited to:

1) Winery/winemaker to grower liaison: Assist wineries and winemakers in procuring fruit that meets their quality specifications. Achieve wine quality goals by quality assurance checking of best viticultural practices and proper timing of harvest;

2) Irrigation management: Strategies, monitoring, and scheduling for superior wine quality;

3) Mineral nutrition: Avoid or identify, and correct deficiencies without getting vines out of balance;

4) Yield and canopy management for ***uniformity*** of ripeness and character;

5) Viticultural technologies: GIS, GPS, canopy density mapping, Precision Viticulture, and moisture monitoring systems;

6) Maturity assessment: Harvest at ***true*** ripeness!

7) On-site research experimentation: Learn what works best for ***you*** at ***your*** site;

8) Weather and climate evaluations: Vintage evaluations and vineyard preplant planning.

For more information, contact:
Advanced Viticulture
Mark Greenspan
tel: 707/568-5256
e-mail: mark@advancedvit.com
website: www.advancedvit.com

Jim's Supply Co., Inc.

Jim's Supply Company, one of the largest and oldest full-service national suppliers of trellising products, is one of the best partners you can have in the successful installation of your vineyard. In business since 1959, Jim's Supply manufactures metal products including stakes, posts, crossarms, and braces, including the signature Superstake Grande, Rolled Edge Vertical Grapestake, and Spaded Drill Pipe End Post that are the standard in vineyard trellising. **Buy direct and save!**

Bird netting supplies, both extruded and woven-style netting, are offered.

Jim's Supply is a leading distributor of quality brands such as Davis Wire, Preformed Vineline, Minuteman, Powder River, and Gripple.

Jim's Supply Company, Inc.

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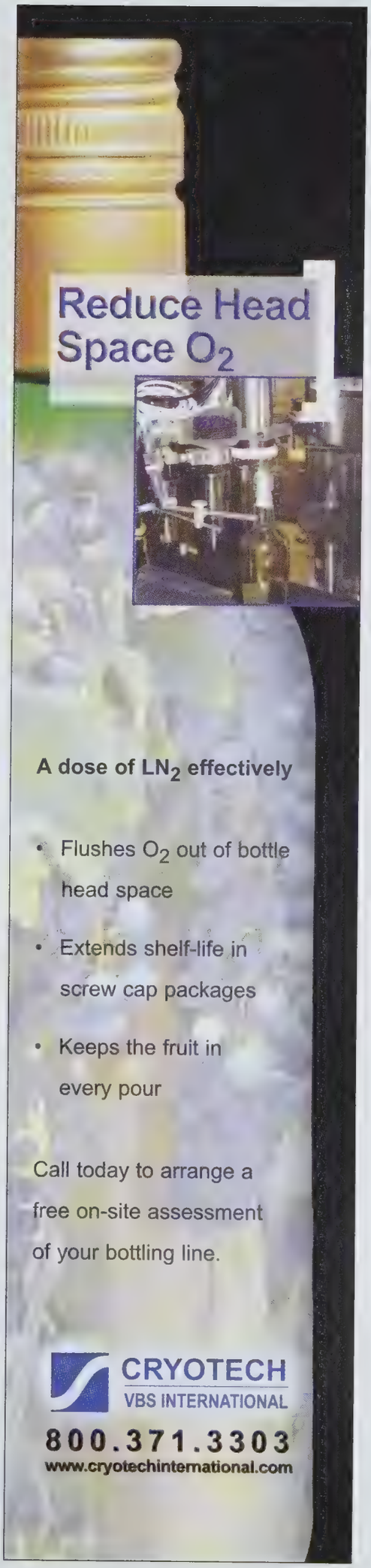
PLEASE SEE JIM'S SUPPLY CO. AD, PAGE 25.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tel: 573/683-3880; fax: 573/683-6227
website: www.kinseyag.com
e-mail: neal@kinseyag.com

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Orchard Valley Supply, Inc.

Orchard Valley Supply has been a wholesale supplier for the vineyard, orchard, and winery industries since 1986, by providing quality products, prompt service, and low prices. Orchard Valley provides everything needed between the vine/plant and the wine/fruit.

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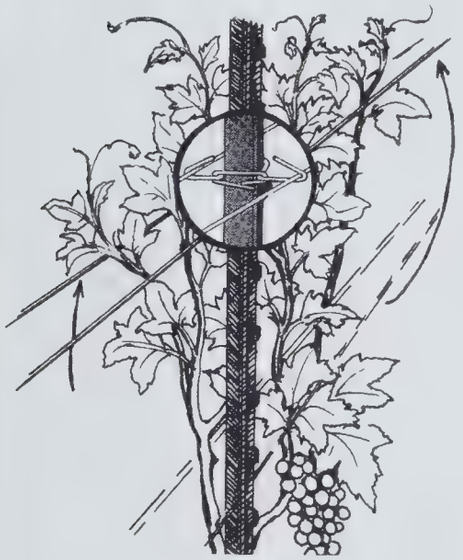

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Paso Robles, CA 93446
tel: 805/226-9960; 800/491-9833
fax: 805/226-9818
website: vineyardindustryproducts.com

PLEASE SEE VIP AD, PAGE 48.

Premiere Viticultural Services, Inc.

Take your vineyard to the next level with Premiere Viticultural Services. Providing services to over 2,000 acres of ultra-premium vineyards in Napa and Sonoma Counties, Premiere is emerging as one of the top vineyard consulting firms in the North Coast. Led by President Steve Matthiasson, the Premiere team focuses on wine quality, and offers state-of-the-art viticultural expertise and a broad experience of all aspects of wine growing.

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Winery Planning & Design

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Winery Design
Design Considerations, Layout, Architecture, Designs and Case Studies, Green Wineries and Sustainable Winegrowing.

Winery Equipment
Equipment Considerations, Equipping a Small Winery, Fermentation and Storage Vessel Considerations, Wine Caves, Gravity Flow Winery Designs.

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Winery Startup Legal Issues, TTB requirements.

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Grover Soil Solutions

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Grover has several spreader configurations to meet vineyard needs, from open field to vineyard, broadcast to banding available as rentals.

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tel: 866/764-5765; fax: 209/545-9083
e-mail: groverls@juno.com
website: www.wondergrow.biz

PLEASE SEE GROVER SOIL SOLUTIONS AD, PAGE 90.

The Winegrowing Consortium

Dr. Paul Anamosa: Vineyard Soil Technologies
Nathan Baty: Viticultural Services
Greg Bjornstad: Bjornstad Consulting
Mike Bobbitt: Mike Bobbitt & Associates
Tucker Catlin: Estate Vineyards
Dr. Mark Greenspan: Advanced Viticulture
Dr. Daniel Roberts: Integrated Winegrowing

After years of collaborating on vineyard design, wine quality improvements, and technical troubleshooting, these independent viticulturists have joined to provide an integrated service. Consortium members are committed to working closely with owners, winemakers, and vineyard managers to improve wine quality while achieving financial efficiency.

Clients — Consortium clients are often wineries with estate vineyards looking to improve wine quality or refocus vineyard activities and grower relations to better support winemaking/marketing goals. Quality, quantity, and costs are all considerations, with most clients in the ultra-premium and luxury categories.

New vineyards — The critical design process begins with a **site assessment** of soils, climate, topography, and wine goals. The final plan integrates blocks with soils and slopes, while selecting the best variety/clone and rootstock, spacing/row direction, and trellis/irrigation combinations for a site. To preserve this design, **ongoing supervision** guides the process through permitting, engineering, budgeting and into planting, training, and production.

Producing vineyards — Long-term winegrowing strategies are also applied to producing vineyards. The effects of pruning, canopy, irrigation, yield, uniformity, and ripening are all integrated to achieve winegrowing goals. For contracted fruit, consortium members evaluate fruit sources and match contracts or leases to a winery's needs. Design, supervision, and interpretation are available for viticultural experiments and weather data, where GIS maps and data management are incorporated into most projects.

For more information, please contact:
The Winegrowing Consortium
tel: 888-897-3030
e-mail: info@winegrowingconsortium.com
website: www.winegrowingconsortium.com

CALIFORNIA GRAPE CRUSH REPORT

2006 harvest 17% below 2005

The California Department of Food and Agriculture released their Preliminary 2006 Grape Crush Report in February reporting that California wineries crushed 3.1 million tons, a 17% decrease from the unexpected record of 3.7 million tons in 2005.

"This is positive news," says John Ciatti, partner in the Joseph W. Ciatti Company (San Rafael, CA). "Combined with reports about per capita wine consumption increasing, this means the market will come back into balance more quickly."

Steve Fredricks, vice president of Turrentine Brokerage (Novato, CA), says, "The 2005 harvest pushed Chardonnay into oversupply but the market for wine in bulk is signaling a much reduced inventory after the 2006 harvest. Interest in Chardonnay is stronger than it has been in seven years."

Glenn Proctor (Ciatti Company partner) notes, "Wineries have treated 'supply' as a four letter word because of the uncertain crop size. They've been afraid to commit to buying grapes. This normal 2006 crop size should bring them back into the grape market."

Ciatti and his partners note some factors in the report of particular interest:

- Total Chardonnay tonnage is the second lowest in five years, down 26% from 2006 to 548,000 tons. "Not only does that show how big 2005 really was," says Proctor, "it also means excess inventories of 2005 Chardonnay will be utilized to fulfill increasing consumer demand" (since there won't be much bulk 2006 Chardonnay).
- Pinot Noir volume increased 11% statewide, with 10,000 more tons in 2006 than 2005 (over 105,000 tons total). "Even that increase," says Ciatti, "won't be enough to fill the Pinot Noir demand." Pinot Noir tonnage in Mendocino County doubled from 2005 to 2006.

"We saw a record Pinot Noir crop with 11% increase in tonnage and a 15% increase in price," says Brian Clements, Turrentine Brokerage partner. "However, this was not nearly enough to meet current demand. We are possibly seeing a minor variety turn into a major variety."

Lake County had a 20% increase in Chardonnay, and Mendocino County increased 10%. About 37% fewer tons were crushed in Monterey, 42% less in San Luis Obispo/Santa Barbara, 27% less in Lodi-Woodbridge, 22% less in Napa, and 16% less in Sonoma.

Fredricks notes that Cabernet Sauvignon declined 22% in 2006 from 2005. "California — and the world — has had an oversupply of Cabernet Sauvignon. Sales of Cabernet are growing rapidly. With this reduced supply, rapid growth should soon drink up the excess supply."

Cabernet Sauvignon tonnage decreased 19% in Napa in 2006, 15% in Sonoma, 21% in Lodi-Woodbridge, 31% in Monterey, 24% in San Luis Obispo/Santa Barbara, and 11% in Mendocino.

Merlot tonnage fell 22% in 2006 from 2005. "Merlot is a supply conundrum for wineries and growers," says Bill Turrentine, president of Turrentine Brokerage. "The 2005 and 2006 harvests produced significant excess supply at the same time that the rate of sales growth flattened out. This caused inventories to swell and has depressed demand for 2007 Merlot grapes, even though the rate of sales growth has now increased.

"There is a real risk that substantial acres of Merlot will be removed because of a weak 2007 grape market. This could be a long-term solution to a short-term problem that could leave brands without the Merlot grapes needed when the 2008 or 2009 harvest rolls around."

Merlot dropped 25% in Lodi-Woodbridge in 2006, 16% in Napa, 18% in Sonoma, 30% in Lake, 28% in Monterey, and 21% in San Luis Obispo/Santa Barbara.

Sauvignon Blanc tonnage decreased 6% statewide. Napa decreased 6% and Sonoma increased 6%, Lodi-Woodbridge decreased 17%, Lake and Mendocino each increased 34%, Monterey and San Luis Obispo/Santa Barbara each decreased 17%.

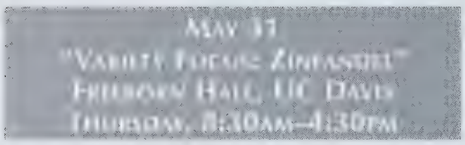
Zinfandel tonnage decreased 24% statewide. Sonoma decreased 7%, Lodi-Woodbridge decreased 33%, Lake increased 19%, Mendocino increased 12%, Monterey decreased 24%, and San Luis Obispo/Santa Barbara decreased 21%.

Throughout California, Riesling decreased 13%, Syrah decreased 20%, Barbera decreased 8%, Carignane decreased 10%, Petite Sirah decreased 17%, Rubired decreased 7%, Ruby Cabernet decreased 5%, while Grenache increased 22%. Pinot Grigio increased 16% in 2006, probably due to new plantings.

Changes in tonnage totals by district were:
Napa –16%
Lodi-Woodbridge –25%
Monterey –30%
San Luis Obispo/Santa Barbara –28%
Sonoma –6%
Lake +11%
Mendocino +14%
Modesto –13%
Fresno –9%
Bakersfield –13%

For consumers, Ciatti notes that the 2006 numbers are more in-line with historical norms, meaning that wine prices should remain stable while wineries work through excess inventories. "There's plenty of Cabernet Sauvignon, Chardonnay, and Merlot available at good prices," says Ciatti. "Consumers should not see a change in prices for those wines." He added, however, that increasing demand for varieties like Pinot Noir, Pinot Grigio and Riesling, will keep inventories tight, so consumers shouldn't expect prices to come down.

The Department of Food and Agriculture will release the final Grape Crush Report in March. ■



The third seminar to focus on the viticultural side of a wine grape variety to examine the origins of Zinfandel; the importance, development, and selection of clones; and hear from experienced Zinfandel winegrowers about their use of this unique variety. Speakers include UC Davis faculty, UC farm advisors, experienced California growers and winemakers, and guest speakers from Croatia, now believed to be the home of Zinfandel.

Charles Sullivan, a leading expert on California wine history and well known for his definitive history of Zinfandel, will speak from years of experience as a Zinfandel historian. Sullivan has conducted extensive research on Zinfandel in the U.S. and Europe. He will share his knowledge of the history of the variety, thoughts on the wine quality produced today, observations on prices (grapes and bottle), geography and alcohol levels, and look to the future of this remarkable grape.

Dr. Deborah Golino, director of Foundation Plant Services (FPS), UC Davis, will talk about the availability of Zinfandel clones in the U.S., effort to preserve Heritage Zinfandel selections as clean stock, and a new project to exchange Croatian and California Zinfandel selections between the University of California and the University of Zagreb.

Dr. James Wolpert, UC Davis viticulture specialist, is project leader for the Zinfandel Heritage Vineyard project, working in concert with emeritus specialist Amand Kasimatis and UC farm advisors Rhonda Smith (Sonoma County), Ed Weber (Napa), Glenn McGourty (Mendocino), Paul Verdegaal (San Joaquin), and Donna Hirschfelt (Amador). Selections of Zinfandel have been collected from many vineyards in 14 counties throughout California. Goals of the project include preservation of potential Zinfandel diversity and improvement of Zinfandel clones available as certified selections through FPS.

Donna Hirschfelt has many years of experience with Zinfandel working as farm advisor in Amador and El Dorado counties to establish clonal Zinfandel trials with selections including those collected in the region. She will present data and share observations from her trials. Wines will be tasted from these research vineyards.

The key discovery that Zinfandel was in fact identical to a Croatian black grape called Crljenak kasteljanski was made by a team that included emeritus professor Dr. Carole Meredith and two professors from the University of Zagreb: Dr. Ivan Pejic and Dr. Edi Maletic. Dr. Pejic and Dr. Maletic will talk about the past, present, and future of Zinfandel in Croatia. Dr. Pejic will explain the genetic evidence for the Croatian origin of Zinfandel/Primitivo/Crljenak Kastelanski (ZPC), the history of ZPC growth in Croatia, and his field experiments with ZPC clones on the island of Hvar. Dr. Maletic will discuss the prospects of ZPC in Croatia in light of high red demands and government support, viticulture experience with the first ZPC plantings, and winemaking experiences with first ZPC harverst. They will pour ZPC wines "made in Croatia" (vintage 2005 and 2006).

Scott McLeod is winegrowing director at Rubicon Estate (Rutherford, Napa Valley that has a 151-year history with Zinfandel grapes. McLeod will discuss efforts to "rescue" two old Zinfandel clones from Rutherford and the steps required. A tasting of these century clones will be included.

David Gates (vice-president of vineyard operations, Ridge Vineyards [Cupertino, CA / Sonoma County] since 1989) will discuss their Zinfandel plantings at Geyserville and Lytton Springs in northern Sonoma County and their use of field selections from pre-Prohibition Zinfandel vineyards for new plantings. Four wines will be compared: three field selections of Zinfandel along with a Zinfandel-base wine into which they are ultimately blended. He will also discuss another project where Ridge is preserving and comparing field selections from old Zinfandel vineyards with FPS 03 Zinfandel and FPS 03 Primitivo (and soon Crljenak kastelanski).

To enroll, please visit the UC Davis Extension website at: www.extension.ucdavis.edu/winemaking.

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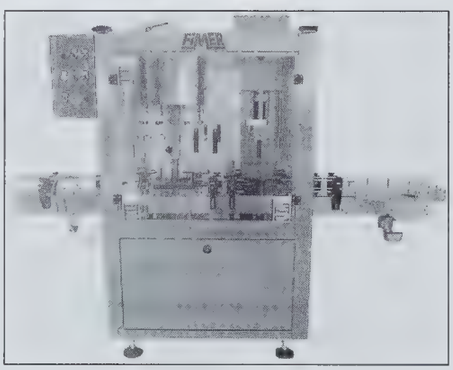

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June 19–22
ASEV Annual Meeting
Grand Sierra Resort, Reno, Nevada

Special events at the American Society for Enology & Viticulture 58th Annual Meeting will include:

Managing Wild Bacterial Flora

Tuesday, June 19

The symposium will cover positive and negative aspects of bacterial flora. Speakers will provide practical information on control and manipulation of flora and cover some discoveries on the metabolic activities of these organisms and their impacts on wine. Methods of detection and monitoring of flora will be presented plus information on management of bacterial populations. Dr. Wessel Du Toit (South Africa) will discuss the impact of microoxygenation on wine microbial flora and Dr. Jose Guillamon (Spain) will discuss control of microbial populations. Other speakers will cover winery sanitation, microbial spoilage in New World winemaking regions, and emerging spoilage issues caused by adoption of new sanitation practices.

O_2 Chemistry / Measurement

The importance of oxygen to winemaking includes the deleterious effects of rapid oxidation and meritorious effects of slow dissolution. A definitive understanding of the mechanisms underlying oxygen reactions with wine components continues to evolve.

What is currently known about wine oxidative chemistry? The role of oxygen in winemaking, from micro-oxidation in young wines to oxygen transfer in bottled wines. What is the role of phenolics in wine oxidation and hydrogen peroxide formation, the importance of metal ion catalysis and the Fenton reactions, and the ability to monitor free radical reactions through electron paramagnetic resonance (a technique that has been successfully applied in the brewing industry).

Clonal Aspects of Winegrowing

Friday, June 22

When selections of the same grapevine variety from different sources are compared, subtle differences in performance between selections become apparent that are caused by mutations in genes that may affect leaf lobing, berry color, disease resistance, or ripening. Mutations can accumulate and lead to greater diversity in older varieties. Selections that differ and have been evaluated are known as "clones" of a variety. Planting superior clones can improve a variety's production and winemaking characteristics.

There is a large amount of clonal material of the major grape varieties in the U.S. Decisions on clones have become an integral part of the vineyard planning process. Growers want to know how clones might enhance viticultural performance and wine quality or help create a particular wine style.

Topics / Speakers: History/Biology of clones, Andrew Walker (UC Davis); Research challenges in clone evaluation, Jim Wolpert (UC Davis); How clonal programs and clean plant programs work hand in hand in development of grape planting stock, Deborah Golino (UC Davis); Future of Clones in World Viticulture, Jean-Michel Boursiquot (Univ. of Montpellier, France); Tannin development in grapes/wines of Pinot Noir clones from California/Oregon; Douglas Adams, (UC Davis); Glenn McGourty (UC Cooperative Extension, Mendocino and Lake Counties).

More information will be posted on the ASEV website at www.asev.org where guests can register to attend the Annual Meeting.

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Saverglass changes hands

The Desjonquères family has sold a controlling stake in Saverglass to Natexis Industrie, Natexis Investissement and Crédit Agricole Private Equity (Paris, France).

Saverglass designs, manufactures, and distributes luxury glass bottles, decanters and perfumery bottles. Saverglass has two production plants in France (Feuquières and Le Havre) which produce 200,000 tons of glass per year. Over the past 15 years, Saverglass has multiplied its tonnage by five, its workforce by six, and its sales by seven. The company has carved out a position as a world leader in luxury bottles for spirits and fine wines.

The glassworks was first founded in 1897, acquired by Henri Desjonquères in 1964, and owned by Saint Gobain from 1969 to 1976, when it was bought back by Luc Desjonquères.

With the arrival of Loïc Quentin de Gromard as Chairman in 1985, the Saverglass Group has capitalized on its unique know-how to implement an aggressive industrial, marketing, and commercial strategy. The goal is to offer a full range of glass bottles, innovative in both shape and quality, and a bottle decoration capability, to a prestigious clientele seeking to differentiate and enhance their products through packaging (Diageo, Constellation, Joseph Phelps, Stags Leap Wine Cellars, Pernod Ricard, Roederer, and Moët Hennessy).

The Saverglass Group has 1,600 employees worldwide and develops its business through its international proprietary network based in the heart of the major emerging winegrowing areas, and through global super premium spirits groups. 2006 revenue was $220 million, including more than 50% in international business. ■

ISO/IEC accreditation for Vinquiry

Vinquiry Inc. has announced the ISO/IEC 17025:2005 accreditation of its Windsor, CA laboratory by the American Association for Laboratory Accreditation (A2LA). This accreditation to ISO provides a third-party demonstration that the Vinquiry Laboratory has the technical and managerial capabilities to produce technically valid data and results.

A2LA is a nonprofit membership association providing formal recognition to laboratories that pass a rigorous assessment based on internationally-accepted criteria for competence (ISO/IEC 17025:2005). It applies to any organization that wants to assure its customers of precision, accuracy, and repeatability of results.

Laboratory Accreditation is different from Quality Systems Registration/Certification. Terms such as "quality system registration" convey a process of verifying that an organization is following a documented quality system in accordance with the quality system elements of standards, such as ISO 9000. These processes do not normally assess for technical competency.

Laboratory Accreditation is defined as formal recognition of an organization's technical competency to perform specific tests, types of tests, or calibrations. The general requirements for laboratory accreditation are defined by ISO/IEC 17025.

In addition, the A2LA has determined that some of the ISO/IEC 17025 requirements, such as Proficiency Testing, need to be explained or interpreted to ensure that the requirements are applied in a consistent manner for all accredited labs. In certain fields, additional specific technical requirements are developed to complement the ISO/IEC 17025 requirements.

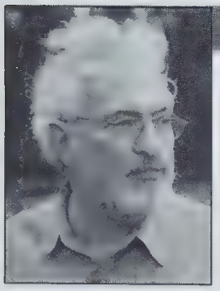
The assessors who conduct laboratory accreditation must be technical experts in their field. The process consists of a visit from A2LA representatives for several days to review aspects such as, the technical competence of personnel, use of well-defined and validated test and calibration procedures, administration of quality systems and management systems, participation in proficiency testing (inter-laboratory comparisons and/or use of reference materials), and analysis of quality control data.

The assessors must verify the laboratory's specific capabilities that are then listed on a "scope of accreditation." A scope of accreditation lists the types of test that can be performed. Once the audit is complete, the report is submitted to the accreditation council who vote to determine if the laboratory is granted accreditation.

The customer-benefit to using an accredited laboratory includes the peace of mind that third-party recognition provides. Accreditation verifies that the analytical procedures used in the lab are accurate. Another benefit is in wine exporting. Exporters trading in the world market need to give assurance of conformity of their products to international standards. Assurance may eventually require ISO/IEC 17025 laboratories.

The report, "Food Export Control and Certification" by Shashi Sareen, Director, Export Inspection Council for the second FAO/WHO global forum of food safety regulators states, "Laboratories used by the export inspection and certification services need to be accredited as per international standard ISO 17025 under officially recognized programs to ensure that adequate quality controls are in place to provide for reliability of test results." To this end, having export documents created by a laboratory that is accredited to ISO/IEC 17025 in addition to TTB-certification may become essential to trade.

Through the course of the accreditation process by Vinquiry, enhanced QA/QC measures were instituted, and verification systems for analytical results. Completing the process was a key goal for the company in 2006, proving that Vinquiry is able to offer the best services available to the wine industry. ■



Site characteristics and rootstock selection

Can knowing rootstock characteristics assist in choosing the correct stock for vineyard development? Yes, but the information available is limited. For example, if a site has no nematode problems and salinity and sodicity are not issues, then how does one choose between 420A and 101-14?

Site characteristics are very important in deciding rootstock choice. A rootstock experiment was established by Sterling Vineyards (Napa Valley, CA), in cooperation with University of California, Davis in the late 1980s. Rootstocks planted included 110R, Riparia Gloire, 101-14, and 3309C. The soils series was Pleasanton loam, which was ripped to three feet in depth prior to planting.

Within a few years, there were very few differences between the vines in terms of overall growth, cane length, internode distance, and yield per vine. The only observed difference was that Riparia Gloire had smaller trunk diameters than the other rootstocks. The conclusion was that in deep, rich soils, rootstock differences were minimal.We have since shown that ripping depth can be used to limit vine size in these deep soils. This will be discussed in more detail in the May/June column.

Site characteristics that may be important in rootstock choice include:

1. Soil — biology, chemistry, and physics;
2. Climate — rainfall (amount and frequency), wind (speed), temperature; and
3. Topography — aspect and slope.

Below, we will review soil biology in relation to nematodes and mycorrhizae as well as soil chemistry in relation to pH, magnesium and boron content. In the next column, we will discuss soil physics in relation to texture, and how structure relates to water holding capacity. Salinity and sodicity will also be discussed in the next column since these problems are interwoven with soil structure. Climate and topography will be reviewed in the July/August column.

Soil Characteristics — Biology

Nematodes

The nematode issue in rootstock choice is very important, but also complicated. In any site to be evaluated, new or replant soil samples should be taken for nematode analysis. Old orchards such as walnut, apricot, and apple could have significant populations of rootknot and other nematodes. The book *Grape Pest Management* (1992) has guidelines on sampling soil for nematodes. Another very good resource is the Kearney Agricultural Center website (www.uckac.edu).

Words used in discussing nematodes, such as resistance, tolerance, and susceptibility, need to be well-defined.

Resistance is when vine roots do not support nematode reproduction. In a study of 42 rootstocks, Mike McKenry reported that 1616C was not resistant (0 reproduction), but did better than any other rootstocks in the study (McKenry, personal conversation).

According to McKenry, 420A proved resistant for 12 years to ring nematode in Mendocino County, but when planted at Kearney Agricultural Center the resistance broke down because of the heat.

The rootstock 101-14 has some resistance to ring and some dagger nematodes but not to rootknot nematodes.

Tolerance is when a vine is not damaged, but it supports reproduction of nematodes. The vine will still be there in 20 years. For example, the rootknot nematode resistance of Freedom breaks down after approximately 14 years, so it is technically not considered to be tolerant.

Susceptibility means "that the vine supports nematode reproduction" from the beginning and may die in a few years. Riparia Gloire is very susceptible to rootknot and dies quickly if planted in the presence of this pathogen.

If your site has populations of rootknot nematodes, rootstock selection is limited. Rootstocks derived from *Vitis champini* (Freedom, Ramsey, Dogridge) accumulate potassium (Wolpert, 2004; Hale, 1977), which can influence juice pH.

Two relatively new rootstocks (RS3 and RS9) have been tested by McKenry, who reports that RS3 has the lower vigor of the two. These rootstocks need to be further evaluated in trials where rootknot nematode is found.

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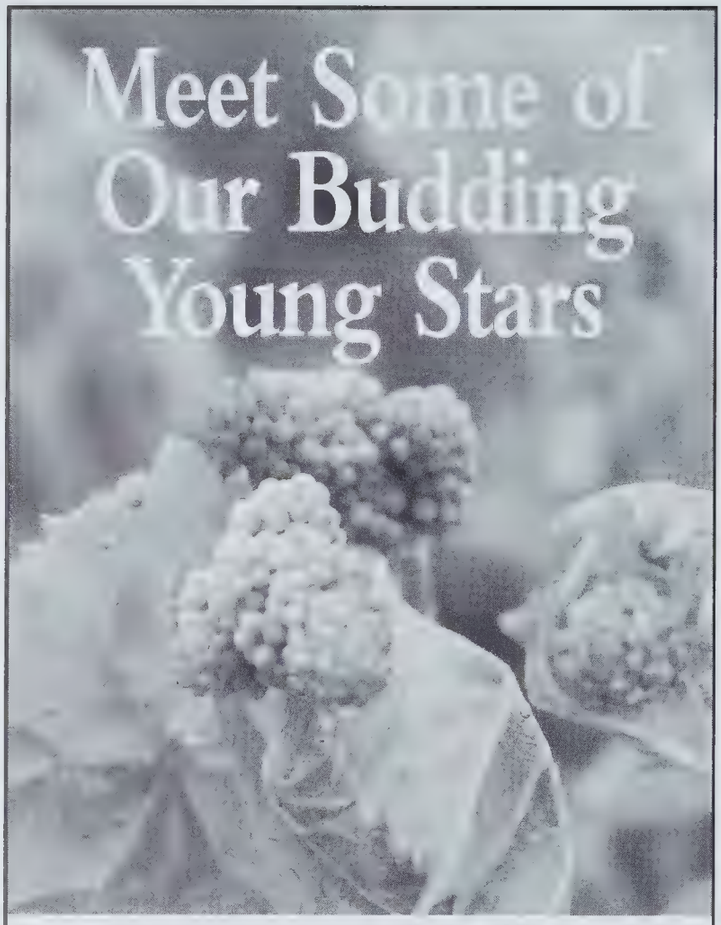

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Mycorrhizae

Despite extensive research on mycorrhizae, there is confusion regarding the best methods for encouraging colonization of grapevine roots by arbuscular mycorrhizal (AM) fungi. In addition, some believe that the resulting symbiotic relationship between the AM fungus and the grapevine is a "cure-all" for a broad range of nutrient problems.

Vine roots host AM fungi infections that can improve phosphorus (P), copper (Cu), and zinc (Zn) uptake. This association increases uptake of these nutrients primarily through increased physical exploration of the soil by the soil-inhabiting component of the fungus and, for some nutrients, due to the ability of the fungus to capture different chemical forms of the nutrients. Mycorrhizal hyphae are smaller than vine roots and can access soil pores and organic matter where vine roots cannot.

AM fungi are "obligate symbionts" and thus require a plant host to survive. A hypha arising from a germinating spore or originating from a mycorrhizal root can colonize a root, developing an internal mycelium and producing specialized structures (vesicles and arbuscules). The arbuscules penetrate into cortical cells, but they never break the host cell plasma membrane.

The most important benefit of mycorrhizal colonization of vine roots is phosphorus uptake. Fungal hyphae are able to take up phosphorus from the soil solution, translocate it to internal mycelium, and then transfer it to the host. The mechanism of uptake is similar to that of root hairs, but the hyphae and have greater length per unit of soil (meters per gram of soil).

Research with an isotope of P^{32} has shown that the specific activity of phosphorus in both mycorrhizal and non-mycorrhizal roots was equal to that of the soil solution. The data indicated that there was no solubilization or transfer from organically bound or inorganically crystallized phosphorus. Therefore both plants were taking in phosphorus from the pool in equilibrium with the soil solution (Tinker, 1975, Symp Soc. Exp. Biol.).

Uptake and transfer of nitrogen (N) from the fungi to the host has been recently shown (Hamel and Smith, 1992, *Soil Biol Biochem*). The effect is small and there is no evidence that fungal hyphae can break down organic nitrogen.

Elements other than P and N can be taken up and translocated to the host by the fungal hyphae. But it is important to understand the difference (yes)between uptake, translocation, and a growth response by the host. The list of elements with which a growth response has been shown includes phosphorus, copper, and zinc.

Menge et al. (1983) showed that vines planted in soil fumigated with methyl bromide, which kills AM fungal propagules, can become severely stunted. To identify methods of encouraging mycorrhizal colonization of grapevines, especially those planted into fumigated soil, Cheng et al. (2004) evaluated different types of nursery stock for naturally-occurring levels of AM fungi. Their finding that colonization was significantly greater on field-grown bench-grafts than potted bench-grafts suggests that a vineyard planted in fumi-

gated soil may benefit from the use of field-grown bench-grafts.

Kendra Baumgarter (U.S. Department of Agriculture), has indicated that AM fungal spores are more abundant in cover-cropped soil than in disked soil. Greenhouse studies on rootstocks growth in P-limited soil showed that all rootstocks and own-rooted vines tested were highly responsive to inoculation with AM fungi (Linderman et al., 2001). Results also showed that inoculated plants of five rootstocks tested did not vary significantly in the degree of colonization in their growth response. Therefore, the research does not indicate that different rootstocks become colonized more quickly than others, but does indicate that type of planting material and vineyard floor management can have a significant influence on mycorrhizal colonization.

Soil Characteristics — Chemistry

Soil pH

South African grape growers indicate that 140-R, 99R, and 110R have tolerance to soil acidity as low as 5.0 (Conradie,1983). In California, I have not observed any differences in rootstock performance in acidic soils. I have seen severe negative influences on vine growth when the soil pH is less than 5.0.

Below pH 5.0, aluminum (Al) solubility increases and can reach 1500 mg/kg at pH 4.5 in several California soils, such as Forward, Boomer, and Sebastopol series. There is no research in California on the influence of aluminum on vine growth or on rootstock selection. Research on other crops has shown that aluminum interferes in phosphorus, calcium, and magnesium utilization. Malcolm Sumner, Ph.D. (Professor emeritus, University of Georgia) has indicated that plant roots become stubby due to aluminum blocking cell mitosis and plants will often show water stress due to this root damage.

Observations made in California over 20 years of planting vines in acidic soils has shown some vine stunting at 150 to 200 mg/kg of soluble aluminum (KCl extraction) with severe growth limitations when soluble aluminum exceeds 500 mg/kg. Liming provides a limited solution since it is very insoluble and usually influences soil pH in the top 12 to 18 inches of the soil profile.

When gypsum is applied to a soil, it leaches down into the subsoil, increasing the calcium content and reducing aluminum toxicity significantly. Research by Farina and Channon (1988, *Soil Sci. Soc. J.*) showed that applied gypsum increased rooting depth to 24 to 40 inches for corn and soybeans compared to the lime control. Comparisons of applied gypsum to many mechanical methods for lime incorporation

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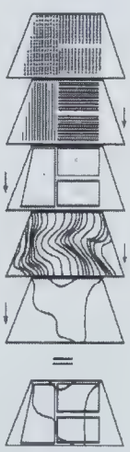

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indicate that gypsum is more effective in reducing the negative effects of subsoil acidity.

Sumner 1990, Florida Institute of Phosphate Research) demonstrated that a single application of gypsum was still measurable in alfalfa yields and soil properties eight years after application. Even though gypsum is expensive, when averaged over time, the costs are relatively low.

Gypsum application shows a decrease in exchangeable aluminum and increased calcium in the soil profile. There may also be a small increase in soil pH (0.1 to 0.3 units). Sumner (1993, *Advan. Agron.*), reported that an increase in the levels of sulfate (SO_4^{2-}) in subsoil causes much of the soluble Al^{+3} to become complexed as $AlSO_4^{+}$, which is non-toxic.

Gypsum does not influence soil manganese levels, but vines (unlike many annual crops) have a high tolerance to manganese, and only under anaerobic acidic conditions can manganese toxicity become an issue.

Soil pH itself has almost no influence on vine growth and once aluminum toxicity is reduced, vines grow very well in soils with very acidic pH. Soil acidity does not need to be a factor in rootstock selection.

Soil Magnesium

Magnesium (Mg) is an ion that has both positive and negative effects for viticulture. On one hand, if sodium (Na) is high, it provides an effective counter ion to the adverse effects of sodium on soil structure. However, if calcium is very much lower than the magnesium concentration, then magnesium will cause some soil physical problems such as high soil density and high soil strength. High exchangeable magnesium has negative effects on vine nutrient uptake. In particular, potassium economy is adversely affected in vines growing in magnesic soils (Anamaosa, 2004).

When magnesium is in the optimal range of 20% to 40% of the cat-ion exchange capacity(CEC), the soil is classified as "non-magnesic." However, when soils have higher amounts of magnesium they are classified as "magnesic." When the absolute concentration of magnesium approaches the critical limit of 200 mmol/kg, the soil is classified as "very magnesic."

Serpentine soils have very high levels of magnesium, and lower calcium levels than non-serpentine soils. Levels of nitrogen, phosphorus, and potassium are below the amount required for vine growth, and the heavy metals, chromium (Cr) and nickel (Ni) are often in high concentrations. In California soils, chromium is not a problem because it is insoluble except at very low pH.

In serpentine soils with pH less than 6.0, nickel may be a problem for vine growth. Analyzing for nickel is difficult because one of the principle factors influencing the useful-

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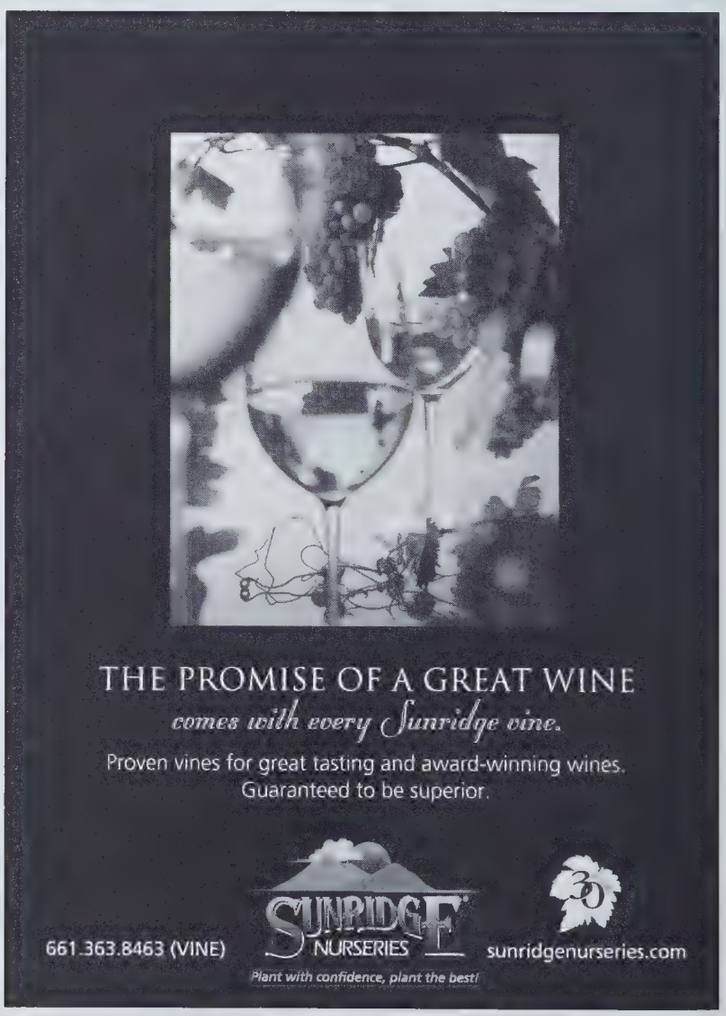
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ness of a nickel analysis is the availability of a correlation between nickel in the soil and vines. For California vineyards there is, as yet, has been no research on nickel toxicity.

Research on pine seedlings in Virginia showed that nickel had a greater negative influence on potassium uptake than Ca/Mg ratios (Miller et al., 2000).

If the soil to be planted is magnesic, then it is best to use a rootstock such as 101-14, which accumulates higher levels of potassium than 420A. In an Oakville vineyard, five years of petiole analysis of 420A and 101-14 planted next to each other showed that the Cabernet Sauvignon on 101-14 had higher petiole levels of potassium at bloom and veraison than those planted on 420A. Research by Wolpert (2004) indicated that 101-14 and 3309C consistently had higher petiole potassium than 420A.

Boron

Most California soils are deficient in boron, but there are a few locations were irrigation water can contain high levels of boron. In poorly-drained clay soils, boron in irrigation water should not exceed 1.2 mg/l, and in well-drained soils, boron can reach 2 mg/l.

In a rootstock experiment conducted in the late 1980s (Calistoga, CA), on soil irrigated with high boron water (more than 20 years), soil boron levels exceeded 3 mg/kg.

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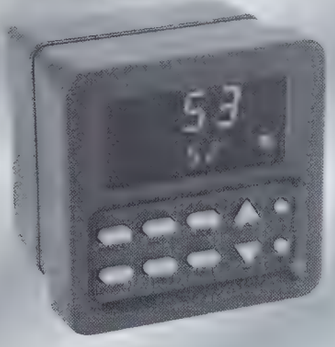

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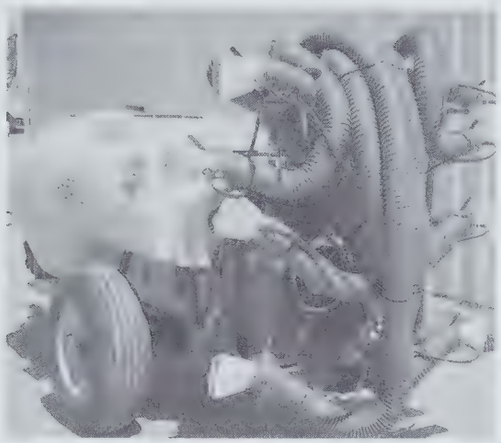

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Sauvignon Blanc was planted on St. George, SO4, 101-14, and 3309C rootstocks. Vines on St. George showed boron foliar toxicity symptoms but produced enough leaf area to ripen fruit. Vines planted on SO4, 101-14, and 3309C were severely stunted and did not produce any fruit. Blade analysis indicated an excess of 120 mg/kg boron, regardless of rootstock. ■

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Dr. Daniel Roberts, Integrated Winegrowing, LLC, has been a viticultural consultant since 1997. His experience includes eight years at Kendall-Jackson Wine Estates (California), and ten years at Sterling Vineyards (Napa County). Contact Dr. Roberts by phone: 707/824-6946 or e-mail: daniel@intregratedwinegrowing.com.

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PERSONNEL POINT OF VIEW *by Anne Heron*

What did you expect?

To paraphrase Alexander Pope: "If you expect nothing, you'll never be disappointed." Unfortunately, you'll never succeed in business either. This column is aimed primarily at managers, supervisors, team leaders, and others who have formal responsibility for getting things done through others.

Even if you're not normally in this role, it's likely that occasionally you expect things of others in order to get your job done. If you're one of those rare individuals who works completely alone, these tips may still help you get things done through others around the house or when organizing the next event for your favorite charity.

The idea for this column came as a result of a series of phone calls I'd received lately from clients. The situations were different — determining an appropriate salary increase, hiring a new manager, creating a bonus program — but the concern was the same in each case. The callers were disappointed in the results being produced by the people they supervise and wanted to do something to get back on track. In each of these discussions, we realized that the one consistently missing element was a clear, focused conversation about expectations.

Here are some steps you can take to ensure that your expectations are clearly stated and understood.

1. Describe what needs to be done in terms of expected results.

Describing expectations in terms of the results to be accomplished may seem obvious; however, when I talk with supervisors, they are sometimes frustrated because an employee has done what they've been asked to do without achieving the expected result. The key is to let employees know the end purpose of the requested task or activity, so they focus on achieving those results rather than just on completing tasks.

This communication problem shows up most often when an employee is told that he or she should go to training, when in reality, the desired result is that the employee accomplishes a task or demonstrates a skill. For example, an assistant tasting room manager is asked to attend supervisory training, when the expectation is really that she should improve the sales performance of her staff. Or a cellar worker is sent to forklift training when the expectation is really that he be able to move pallets during harvest. In these cases, the training is only a means to the end and not the end in itself.

One important benefit of focusing on the results in these situations is that you may find that training is not the only thing necessary to get the performance you need. There may be other factors that impact results.

In our example, poor tasting room sales performance may result from staff's lack of sales skills, from an unattractive new pricing strategy, or from wine availability issues.

The cellar worker's inability to take over forklift duty during harvest may be because he wasn't able to get practice time on the equipment in order to develop his skills, or it may be that the person he should be sharing the task with won't relinquish it. By discussing the expected results, you are more likely to learn of these additional concerns and the employee is more likely to be successful.

2. Explain why the task is important and how it fits into the larger picture.

Providing a context will have a number of added benefits. It lets the employee know that what he or she is doing has value to the overall success of the winery. It also gives a point of reference if he or she needs to solve a problem or make a decision on a task. Even more important is that it will help employees understand the overall impact of their work, which is critical as winery operations become more complex.

For example, in many wineries, the tasting room staff no longer just sells a few bottles or cases of wine. They are actually part of a "direct-to-consumer" sales team that includes the wine club, e-commerce, marketing, hospitality, special events, and more.

For the direct-to-consumer strategy to be most successful, each team member needs to know about the strategy and the objectives of the team's combined efforts. If they understand the bigger picture, the tasting room staff will be more likely to encourage wine club sign-ups, gather emails, promote events, and communicate about the brand in a way that will foster wine purchases through whatever means are most convenient for the consumer — web, email, direct shipments, or visiting the tasting room.

In production areas, the importance of completing work orders is usually very clear. When a task is finished, the result is tangible. The end product can usually be readily seen in tanks, barrels, or bottles. What may be less obvious is the impact of these tasks and how they are done on the larger winery operation.

For example, working safely is important for OSHA compliance, managing worker's compensation costs, and avoiding injuries to other employees. Cleanliness impacts wine quality and, if the cellar is visible to the public, it may impact sales or the customers' winery experience.

As wineries strive to become more efficient, employees are being asked to "work smarter" and take ownership of the results they produce. Providing them with information — about how their work fits into the overall operation, the impact that their mistakes have on others, the value that a job well done has on the rest of the winery — will help them make the contributions required of them.

3. Agree on measurable performance standards for the task.

This step has three parts. First, you must identify performance standards for the task. Second, you must determine how these standards will be measured. Finally, you must come to agreement with the employee on the standards to be used.

You may ask why agreement is necessary. It is much easier to obtain performance results from an employee who has had a chance to discuss, understand, and perhaps negotiate, the standards required. This is an opportunity to educate employees about the reason for the standards and why they are important.

Numerical standards are fairly straight-forward:produce so many widgets within this timeframe; sell so many dollars or cases per day; achieve less than this much downtime; make fewer errors.

Sometimes, however, the required performance standards are more "qualitative" or "subjective." If you want to see things like teamwork, courteous service, attractive labeling, or a complete recommendation, you will need to clearly describe what you're looking for. Give examples, demonstrate how you expect a task to be done, identify what you are expecting in the final result.

4. **Discuss how the task will be accomplished, any guidelines to be followed, and what resources will be required.**

Provide standard operating procedures, regulatory requirements, or other guidelines that have been established for the position. It would also be helpful to review the winery's values statement or other documents that provide guidance on expected behavior and the culture you're trying to create. Providing information about how a task is expected to be done should include both the actual steps to take (do this first, then this, then that, etc.) along with the preferred approach (be warm and friendly, "the customer is always right," etc.).

At this step, it is also important to identify the resources that may be necessary to accomplish results. Where are supplies kept? Are there other departments or individuals who need to provide information? Who is available to answer questions? What support can you provide?

5. **Check for understanding and commitment.**

Before you send the employee off to begin the task, make sure there's time for any last minute questions. You could also ask questions of your own to encourage ownership and accountability. "How are you going to get started?" "What will your next steps be?" "What do you think will be the most interesting part of this assignment?" "What are you looking forward to?" "What obstacles do you anticipate and what can we do about them?" "What improvements can you make in how this is done?"

6. **Set a date for an early progress review.**

Finally, you should follow-up soon after the assignment, to make sure your expectations were clear and all resources are available. Especially if the employee is new to the position or the task is a complex one. Once you know that everything is going well, regular check-ins on a periodic basis should be all that is necessary.

Performance expectations

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Measurable, Achievable, Relevant, and Timely. This also holds true for setting any type of performance expectations. Let the employee know what you're looking for as specifically as possible.

If appropriate, show the employee what a completed assignment will look like when it's done well. Let the employee know how you will be measuring performance. Discuss expectations to reach agreement about what resources and support will be needed to achieve them. Provide a context for the importance and impact of the task. Set timeframes for follow-up and completion. Finally, step aside and let the employee achieve great results.

As Teddy Roosevelt once said, "The best executive is the one who has sense enough to pick good people to do what needs to be done, and self-restraint enough to keep from meddling with them while they do it." ■

Anne Heron is a senior associate with The Personnel Perspective, a human resources consulting, training, and recruiting firm in Santa Rosa, CA. Anne has over 25 years of management and HR experience. You can contact her at 707/576-7653.

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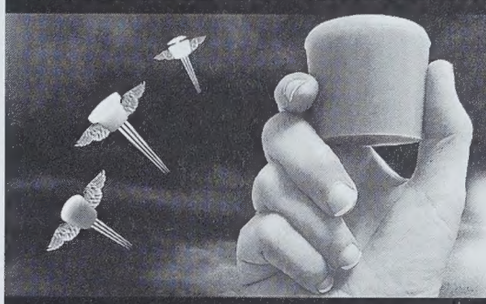

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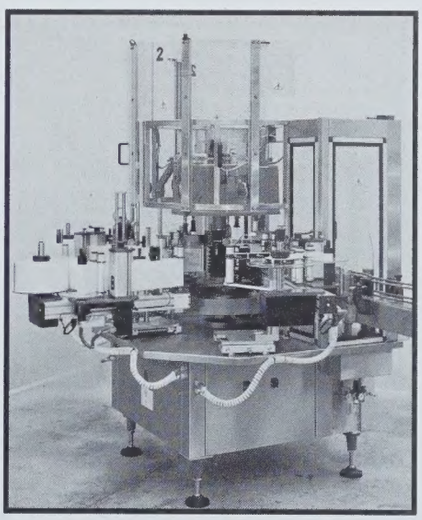

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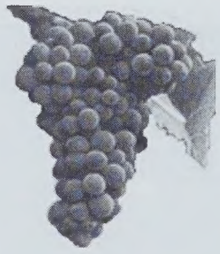

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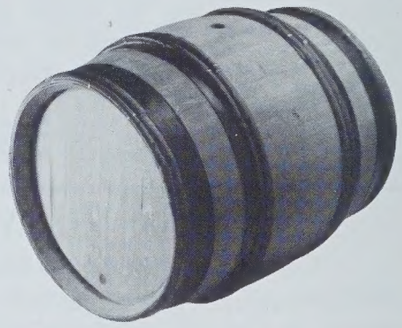

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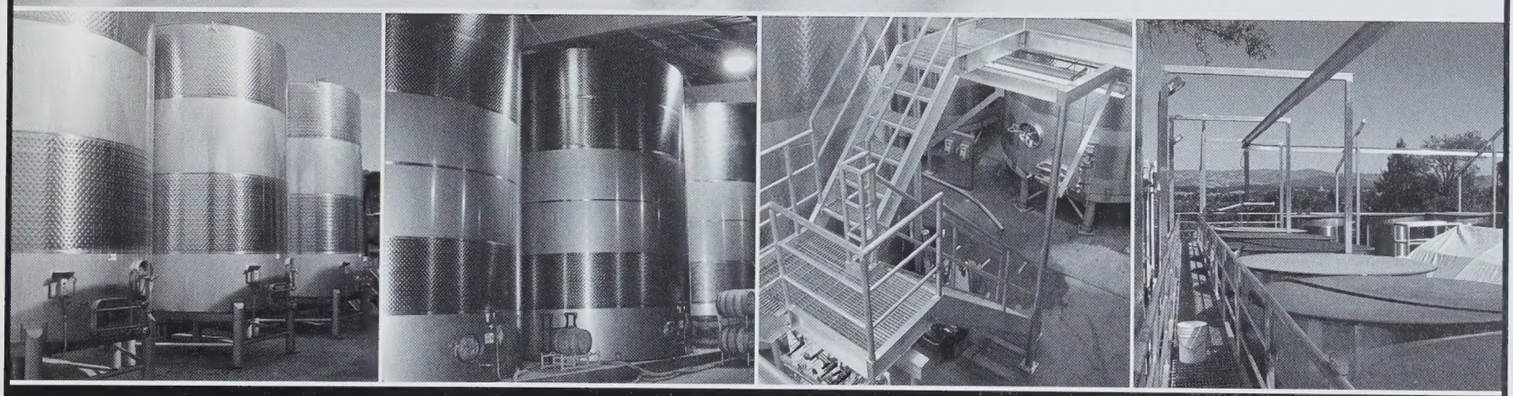

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